17311

First Five-Year Review Report

for
Kummer Sanitary Landfill
Northern Township
Beltrami County, Minnesota

March, 2003

PREPARED BY:

U.S. EPA - Region 5

Approved by:

William E. Muno
Director, Superfund Division

3/13/03
Date

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List of Acronyms

ARAR	Applicable or Relevant and Appropriate Requirement
AOP	Advanced Oxidation Process
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
EPA	United States Environmental Protection Agency
FSR	Final Site Remedy
HRL	Health Risk Limit
GWOU	Groundwater Operable Unit
MCL	Maximum Contaminate Limit
MSL	Mean Sea Level
MHD	Minnesota Health Department
MPCA	Minnesota Pollution Control Agency
NPDES	National Pollutant Discharge Elimination
NPL	National Priority List
NOC	Notice of Compliance
O & M	Operation and Maintenance
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCOR	Preliminary Close Out Report
PRP	Potentiall Responsible Party

PSFD	Pilot Scale Field Demonstration
RA	Remedial Action
RD	Remedial Design
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SCOU	Source Control Operable Unite
VOC	Volatile Organic Compounds

Executive Summary

The remedies selected at the Kummer Sanitary Landfill Superfund site in Northern Township, Beltrami County, Minnesota included:

- The Record of Decision (ROD for Operable Unit 1 (OU) was signed on June 2, 1987, the ROD addressed provisions for an alternate water supply for the affected residents in Northern Township, Minnesota, consisting of constructing two wells in a deep uncontaminated aquifer, a water tower and distribution system. The location of the wells were in an area unaffected by the landfill. First year Operation & Maintenance costs were included to provide the labor, power and chemical supplies for the recommended alternative.

- OU 2 ROD was signed on September 30, 1988, this remedy was a remedial alternative for the Kummer Sanitary Landfill site. This was a source control operable unit to cover the landfill with a low permeability cap and to undertake other actions consistent with state sanitary landfill closure requirements.

- The ROD for OU 3 the last OU was signed on September 29, 1990, the ROD initially called for an Advanced Oxidation Process (AOP) system to address contaminated groundwater leaving the Site and the discharge of treated groundwater using an infiltration pond. This ROD was amended on November 21, 1995 to change the OU 3 remedy to insitu biodegradation and long term monitoring of the groundwater.

The assessment of this five-year review found the remedy was constructed in accordance with the requirements of the Record of Decisions (RODs). One ROD amendment was issued to change the Final Site Remedy (FSR) or third operable unit (OU3) for the Site. The ROD amendment was signed on November 21, 1995. The amended ROD initiated insitu biodegradation and long term monitoring of the ground water. The original FSR for OU3 was described in a Record of Decision (ROD) issued on September 29, 1990. The remedy is functioning as designed. The immediate threats have been addressed and the remedy is protective of human health and the environment.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION

Site name *(from WasteLAN)*: Kummer Sanitary Landfill

EPA ID *(from WasteLAN)*: MND980904049

Region: 5	**State:** MN	**City/County:** Northern Township/Beltrami

SITE STATUS

NPL status: ☐ Final x Deleted ☐ ~~Other (specify)~~ ______________________________

Remediation status (choose all that apply): ☐ Under Construction ☐ Operating x Complete

Multiple OUs?* x YES ☐ NO	**Construction completion date:** 06 /22 /2000

Has site been put into reuse? YES x NO Portions

REVIEW STATUS

Lead agency: ☐ EPA x State ☐ Tribe ☐ ~~Other Federal Agency~~ ______________________

An author name: Gladys Beard/ State PM Name Jean Hanson

Author title: NPL State Deletion Process Manager	**Author affiliation:** U.S. EPA, Region 5

Review period: ** _11_ / _04_ / _01_ to _02_ / _28_ / _03_

Date(s) of site inspection: September 2002

Type of review:

X Post-SARA ☐ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site X NPL State/Tribe-lead
☐ Regional Discretion

Review number: x1(first) ☐ (second) ☐ 3 (third) ☐ Other (specify)

Triggering action:

X Actual RA Onsite Construction at OU 3____ Actual RA Start at OU3____
Construction Completion Previous Five-Year Review Report
~~Other (specify)~~ ______________________________

Triggering action date *(from WasteLAN)*: 10 /01/ 1997

Due date *(five years after triggering action date)*: 10/30/2002

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

FIVE-YEAR REVIEW SUMMARY FORM, cont'd

Issues:

Continue with routine site maintenance including annual mowing of the vegetative cover and site inspections of cover and integrity cover. Continue with groundwater and surface water sampling program.

Recommendation and Follow-up Actions:

Evaluate potential migration of groundwater contaminants and conduct additional sampling and groundwater analysis.

Continue with routine site maintenance and annual mowing to the cover.

Protectiveness Statement(s):

All immediate threats at the site have been addressed, and the remedy is protective of human health and the environment in the short-term.

Long-Term Protectiveness:

The source control provided is a low permeability cover over the Site's landfill. The cover has achieved its design criteria by significantly reducing both the production of leachate and the toxicity of the compounds released from the Site's landfill. Maintenance of the Site's landfill cover such as mowing, inspections for erosion or other damage and maintaining proper slopes for positive drainage off the fill area, will continue in order to maintain the integrity of the cover system.

Other Comments:

None.

Kummer Sanitary Landfill
Northern Township, Beltrami County, Minnesota
First five-year Review Report

I. Introduction

The purpose of the five-year review is to determine whether the remedy at the site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and identify recommendations to address them.

The Agency is preparing this Five-Year Review report pursuant to CERCLA §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The Agency interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The Minnesota Pollution Control Agency (MPCA) and the United States Environmental Protection Agency (EPA), Region 5, conducted the five-year review of the remedy implemented at the Site. This review was conducted by the Project Managers for the entire site from November 4, 2001 through February 28, 2003. This report documents the results of the review.

This is the first five-year review for the Site. The triggering action for this five-year review was the start of actual remedial action on-site construction. The five-year review is required due to the fact that hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

I. Site Chronology

Table 1 - Chronology of Site Events

Event	Date
NPL RP Search	1/07/1991
Removal Assessment	1990-1991
Proposal to NPL	10/15/1984
Final listing on EPA National Priorities List	6/10/1986
Administrative Records Start	3/29/1988
Remedial Investigation/Feasibility Study (RI/FS) made available to public	6/12/1985
ROD for ALT water Supply	6/12/1985
ROD for SCOU	1988
ROD for GWOU	1990
Remedial Design Complete for OU1	5/11/1989
Remedial Action Complete for OU2	9/04/1991
Remedial Design Complete for OU1	12/21/1990
Remedial Action Complete for OU2	12/12/1992
Remedial Design Complete for OU3	6/02/1997
Remedial Action Complete for OU3	06/30/1998
Pre-final inspection	2000
Preliminary Close Out Report signed	6/22/2000
Deletion from the NPL	4/26/1996
Construction start	10/1997
ROD Amendment	11/21/1995
Site Inspection	09/2002

III. Background

Physical Characteristics

The Kummer Sanitary Landfill is located in Northern Township, Beltrami County, Minnesota, approximately one mile west of Lake Bemidji. The site is located along the north side of Anne Street, N.W., and midway between U.S. 71 and county State-Aid Highway 15. The northern corporate limits of the City of Bemidji are one-half mile south of the site.

The Kummer Sanitary Landfill was opened in 1971 with Solid Waste Permit Number 31 from the MPCA. Until 1983, the landfill accepted material described only as mixed municipal waste. The waste was deposited in the landfill using a trench and fill technique, and early trenches were located along the southern, western and northern borders. Cover material was excavated from borrow areas within the landfill property, and these borrow areas later became active landfill disposal sites. The landfill area occupied a major portion of the property by 1984.

During the operation life of the landfill, poor operations at the site caused the MPCA to take a number of administrative and enforcement actions.

On March 6, 1979, a Notice of Noncompliance was issued to Jon Kummer for failing to comply with MPCA Solid Waste Rule 6 (SW-6). A Notice of Violation was then issued to Jon Kummer on May15, 1979, for his failure to comply with Rule SW-6. Jon Kummer failed to comply with the requirements of corrective action set out by both these notices.

On December 18, 1979, Jon and Charles Kummer entered into a Stipulation Agreement with MPCA in order to bring the landfill into compliance with Minnesota rules and regulations. However, the MPCA later found that conditions in the Stipulation Agreement were being violated, and that there were continued violations of MPCA rule SW-6.

On April 19, 1983, the State commenced legal action against Jon and Charles Kummer for alleged violations of Minnesota statutes, MPCA solid waste and water quality rules, and the December 18, 1979 Stipulation Agreement. The lawsuit was dismissed with prejudice but without costs in April, 1988.

Under the Minnesota Environmental Response and Liability Act (MERLA), a Request for Response Action (RFRA) was issued by MPCA on June 26, 1984. This document requested Charles, Ruth and Jon Kummer to undertake a Remedial Investigation/Feasibility Study (RI/FS) at the landfill, as well as to produce plans for remedial action, closure/continued operation and long-term groundwater monitoring. Charles and Ruth Kummer then indicated that they were not financially able to conduct the work required by the RFRA, and would voluntarily close the landfill. On August 28, 1984, a Determination of Inadequate Response was issued for failure to conduct the RI/FS. At this time, authorization was also given to negotiate and enter into a cooperative agreement with the U.S. EPA and to negotiate and enter into contracts to expend State and/or Federal Superfund monies to conduct response actions at the site.

Land and Resource Use

The landfill property is over 40 acres in size with approximately 35 acres on the site landfilled. The landfill has relatively steep out slopes and a gentle sloping to flat upper surface. It is poor to moderately well vegetated. The landfill cover material was obtained from the extreme northern portion of the site from on-site sand and gravel deposits. The cover may, therefore, be very permeable.

The region is characterized by flat to gently rolling terrain to the north and gently rolling terrain to the south. Surface elevations range from approximately 1,050 to 1,550 feet above mean sea level (MSL). The area contains numerous wetlands and lakes. Prior to agricultural drainage, approximately one-half of Beltrami County was comprised of wetland. Mineral resources of the county consist primarily of aggregated sand and gravel, and peat.

The terrain in the immediate vicinity of the site is very gently rolling. The Site is bounded on the east and west by pasture and/or grain croplands, on the north by woodlands and bog, and on the south by planted woods and a gravel pit. Surface elevation at the site ranges from about 1, 360 to 1,380 feet above MSL. Local surface drainage is generally northward. Approximately one-half mile to the north, a modified stream channel or ditch carries runoff to lake Bemidji.

The Kummer Sanitary Landfill is located within the Mississippi River Headwaters Waterhead. Water resource in the area is considered abundant, with lakes and streams occupying about eight percent of the regional surface area. Stream flow is fairly regular because of storage in lakes, swams, and glacial deposits. Average annual runoff from the watershed is about 5.34 inches.

History of Contamination

The Kummer Sanitary Landfill was opened in 1971 with a permit from the Minnesota Pollution Control Agency (MPCA). Until 1983, the landfill accepted material described only as mixed municipal waste. The waste was deposited in the landfill using a trench and fill technique. Based upon historical information, it is highly probable that the trenches were excavated down to the water table and the refuse placed in direct contact with the water table. Early trenches were located along the southern, western, and northern borders of the property. Cover material was excavated from borrowing areas within the landfill property. These borrow areas later became active landfill disposal sites. The landfill area occupied a major portion of the property by 1984. A demolition debris disposal area near the eastern edge of the site was opened in 1974 and contains fly ash and saw dust.

Initial Response

Groundwater samples were collected from the landfill monitoring wells by MPCA staff in 1982 and 1983. Nineteen volatile organic compounds (VOCs) were found to be present in the downgradient wells. Numerous VOCs were also found in shallow residential wells downgradient of the landfill during sampling by MPCA in 1984.

Although no documentation exists of hazardous waste disposal within the landfill, there is a likelihood that small quantities of hazardous waste, such as paint thinners, solvents and pesticides were included in the municipal wastes. The site was proposed for the National Priorities List (NPL) on October 15, 1984, and finalized on the NPL in June 1986. Repeated efforts by regulatory agencies to require the landfill operator to comply with Minnesota rules and regulations and to close the landfill finally culminated in a temporary order on June 25, 1985, closing the landfill, revoking the permit, and requiring the operator to begin groundwater monitoring at the site.

On September 29, 1984, the U.S. EPA and MPCA executed a Cooperative Agreement for implementing a Remedial Investigation and Feasibility Study (RI/FS) for the Kummer Sanitary Landfill. Following the discovery of groundwater contamination, a Determination of Emergency was issued by the MPCA on July 17, 1984. This permitted the expenditure of State Superfund money for a temporary water supply for affected residents.

Basis for Taking Action

Contaminants

Hazardous substances that have been released at the Site in each media include:

Soil	Groundwater
PCBs	Methylene Chloride
PAHs	1,1-Dichloroethana
Lead	cis 1-2-Dichloroethylene
Benzene	1,1,2-Trichloroethylene
cis 1-2-Dichloroethylene	Trichlorofluoromethane
Tetrachloroethylene	1,1-Dichloroethylene
Trans-1,2-dichloroethylene	1-2,Dichloropropane
Vinyl Chloride	Vinyl Chloride

Chloromethane
Dichlorofluoromethane
Bromomethane
1,2-Dichloroethane
1,1,1-Trichloroethane
Dichlorodifluoromethane
Acetone
Ethyl Ether
Benzene
Toluene
Total Zylenes
Tetrahdrofuran
Ethyl Benzene
1,1,2,2-Tetrachloroethylene
Chloroform
Chloroethane
1,1,2,2-Tetrachlorethane
1,2-Dibromomethane
Bromodichloromethant
1,2-Dibromoethane
Trichloroethene
Methyl Isobutyl Ketone
1,1-Dichloro-1-Propane

The principal pathway of migration of the contaminants of concern and subsequent human exposure was found to be through the groundwater. The Minnesota Department of Health (MDH) and MPCA delineated a three and one-half block area east of the landfill as a well advisory area. Use of groundwater for drinking or cooking results in ingestion exposure. The release of VOCs from bath or shower water can result in inhalation exposure. Skin adsorption during bath and routine washing activity did not appear to be a significant exposure pathway at this site due to the high volatility of the contaminants and their low adsorption potential. The possibility exists for exposure by inhalation of methane or VOCS in the atmosphere, or ingestion of contaminated soils. Implementation of the remedies has eliminated exposure routes.

IV. Remedial Actions

Several Records of Decision have been issued at the Landfill. The first Record of Decision (ROD) was issued on June 12, 1985, for a municipal water system in Northern Township. This is referred to as Operable Unit 1 (OU1). A source control ROD was issued on September 29, 1988, for a low permeability cover over the Landfill (OU2). The Final Site Remedy, or third operable unit for the Landfill (OU3), was described in a ROD issued on September 29, 1990.

Remedial Action Objectives (RAOs) were developed as a result of data collected during the Remedial Investigation to aid in the development and screening of remedial alternatives to be considered for the ROD. The RAOs for Kummer Sanitary Landfill were divided into the following groups:

Remedy Selection

<u>Groundwater Response Objectives</u>

- Provisions for an alternate water supply for the affected residents in Northern Township, Minnesota consisting of constructing two wells in a deep uncontaminated aquifer, a water tower and distribution system. The location of the new wells will be in an area unaffected by landfill.

- First year Operation & Maintenance costs were to provide the labor, power and chemical supplies for the recommended alternative.

<u>Source Control Response Objectives</u>

- Site grading consolidation of waste material.

- Placement of a sloping foundation layer of 1-15 feet of existing and proposed natural soil fill.

- Capping with a cover system consisting of a 0.5 feet gas control layer, a 2.0 foot barrier layer of low permeable material (clay) or a 0.30 millimeter flexible membrane, 1.0 foot drainage layer.

- A 1.5 foot topsoil, cover soil, and vegetation layer to provide protection of the drainage and barrier layers.

- Site deed restrictions limiting future use of site.

- Fencing to restrict access to the site.

- Long-term operation and maintenance to provide inspections and repairs to the landfill cap.

Contaminated Groundwater Response Objectives

- Extraction of contaminated groundwater

- Treatment of contaminated groundwater by advanced oxidation processes

- Discharge of treated groundwater using an infiltration pond

Amended Contaminated Groundwater Response Objectives

- Installation of a pilot scale field demonstration to determine feasibility of insitu biodegradation of the chemicals of concern;

- Installation of a full scale insitu bioremediation system after one year of operation if it is necessary to meet the Maximum Contaminant Level (MCL) for chemicals of concern. This is dependent on the field scale demonstration proving effective at lowering contaminate levels that have not yet reached the appropriate cleanup goals.

- Long term monitoring of groundwater to verify that chemicals of concern are continuing to decline and to measure performance of the pilot field demonstration and or full scale insitu bioremediation system;

- Continued observance of the Minnesota Health Department Well Advisory which regulates the location of future potable wells near the Site;

- Institutional controls in the form of Site access restrictions that protect the remedy; and peration and maintenance of the remedy, including periodic inspection of the Site to ensure protectiveness.

The Site remedy described in the 1990 OU3 ROD was an active downgradient hydraulic control and infiltration pond discharge and included:

- five groundwater extraction wells near the eastern perimeter of the landfill;

- handling and disposal of sludge caused by the precipitation of divalent ions of carbonate and/or hydroxides and metals;

- chemical treatment of the extracted groundwater through an Advanced Oxidation Process (AOP), which involves the addition of ozone, hydrogen peroxide and ultraviolet light;

- discharge of the groundwater effluent to an infiltration pond;

- installation of two additional monitoring wells near Lake Bemidji; and

- long-term groundwater monitoring.

Remedy Implementation

The remedy for the Drinking Water Operable Unit 1, construction of the water system began in June 1987 and was completed in June 1987. The OU2 remedy for source control was completed September 1988. The remedy selected for OU3 was an AOP which used ozone and chemical precipitation to remove contaminants from the groundwater. The treated groundwater would then be returned to the superficial aquifer via an infiltration basin. The MPCA was opposed to the AOP because of the high O & M costs which the state would have to assume for the entire period of operation. The USEPA allowed the MPCA to conduct a bioremediation study and evaluate its effectiveness before installation of the AOP. The bioremediation study was completed in 1994 by the University of Minnesota and concluded that by adding oxygen to the groundwater, vinyl chloride (the only remaining contaminant of concern) could be degraded to levels below the Maximum Contaminant Level (MCL). The results of the bioremediation study were used by the MPCA to successfully amend the OU3 ROD in November 1995. The AOP was replaced by a remedy described as an Active Downgradient Hydraulic Control with In-situ Leachate Containment by Subsurface Oxygen Addition. A one year pilot scale field demonstration (PSFD) was proposed to evaluate its feasibility before full scale implementation. The rationale for changing the remedies that had been selected in 1990 is summarized as follows:

1. All affected receptors have been placed on the municipal water system installed in Northern Township for OU1. Domestic wells in the area down gradient of the Site had been sealed and abandoned according to code. The Minnesota Department of Health (MDH) has established a well advisory or institutional control for the affected area to prevent potential new receptors. The MPCA through the State Attorney General's staff has actively supported this effort.

2. Quarterly groundwater monitoring has shown a steady decrease in the contaminants of concern since the low permeability cap was installed in 1991. The AOP was selected as the FSR in 1990, when contaminant levels were significantly high. When the 1990 ROD was first developed, there were 5 (five) compounds of concern: 1,1,2,2-tetrachloroethene, tichloroethene, trans-1,2-dichloroethene, vinyl chloride, and benzene. Only one of the five compounds, vinyl chloride, was still detected in groundwater downgradient of the landfill. Since the installation of the low permeability cover and passive venting system, the level of vinyl chloride has been approaching the cleanup goal or maximum Contaminate Level (MCL)of 2 ug/1. This was accomplished without remediating groundwater AOP. For example, in two wells at the heart of the plume and immediately adjacent to the fill area (MW-3A and MW-12B), the concentrations now detected are 7 and 3 ug/1 respectively. In comparison, the historic maximum concentration of vinyl chloride detected in these wells were 20 and 94 ug/1 respectively. The only inorganic compound found in elevated concentrations is barium. The Health Risk Limit (HRL) for barium was exceeded in one monitoring well, MW-2A. The trend is fairly consistent in this well, however, it is directly downgradient (approximately 100 feet east) of the area of the landfill that received the waste (boiler ash) containing the barium. Since other downgradient monitoring wells are in compliance, the issue of barium appears to be insignificant.

3. There were technical and feasibility complications with the installation and operation of an AOP that make it less desirable. First, the sludge generated by the system was likely to be hazardous and its proper disposal would greatly increase the cost of O & M. Second, the hydrogeologic information on the area immediately east of the Site does not support the groundwater pumping rates necessary to efficiently operate the AOP. Third, the treated groundwater would have to be discharged to an infiltration basin located near a protected seasonal wooded wetland. Changes in the local groundwater table due to infiltration may cause damage to this sensitive ecosystem. The only other alternative was a surface discharge to a pond on adjacent property which will increase costs due to easement leases and National Pollutant Discharge Elimination System (NPDES) requirements.

4. A two (2) year Bioremediation Study conducted by the University of Minnesota for the MPCA has determined bioremediation is a viable remedy for this Site to decrease the amount of vinyl chloride below the MCL. There are naturally occurring methanotrophic bacteria in the soil and groundwater beneath and immediately east of the Site, which are degrading chemicals of concern under anaerobic conditions. The Bioremediation Study has concluded

that injecting oxygen into the groundwater immediately east of the Site will allow naturally occurring aerobic bacteria to degrade the vinyl chloride in the groundwater to a level below the MCL.

5. The cost of installing and operating the AOP was very high in comparison to the remedy that was proposed as an amendment to the ROD. The estimated present worth of the AOP in 1990, was $6,200,000 versus an estimated worth of $75,000 for the remedy in the amendment.

System Operation/Operation and Maintenance

When the Landfill closed on December 1, 1985, a two-foot final cover system was in place. The cover was upgraded to a six-foot soil cover in 1991 (OU2) under the Superfund process. A two-foot thick compacted clay layer comprises the barrier layer within the six-foot cover system. The final cover has experienced some fairly uniform settlement. This is evidenced by the fact the grouted portion of the gas vents sticks up above the final grade anywhere from 3 to 6 across the landfill surface. In addition, some areas of localized differential settlement were observed along the south slope and in the northwest portion of the landfill. On the east and west side of the Landfill, the perimeter drainage ditches have also settled resulting in ponded water and improper drainage along the edge of the Landfill. Some areas of sparse vegetation were noted on the south slope and appeared to align themselves with the trenches that were made in the final cover system in 1993/1994 during the active gas extraction demonstration. These trenches apparently broke through the barrier layer and were not adequately sealed when backfilled so that gas is escaping in these areas. Sparse vegetation was also noted on the north and east slopes. Fox holes were found in the northeast corner of the fill area and other varmint holes were observed in the northwestern and southwestern areas.

The Landfill has a passive gas venting system consisting of 23 deep vertical vents. The gas vents were randomly sampled twice in 2000. The first sampling round did not indicate that there was much gas being vented from the Landfill, however, gas levels increased during the second sampling round indicating that the wells continue to properly vent landfill gas. In addition, there are 18 capped vent pipes that may have been installed as part of the active gas extraction demonstration in 1993/1994, or may be the original gas vents that were abandoned and replaced. An investigation should be conducted to determine if the continued presence of these additional vents is necessary or if they can be removed to facilitate mowing and maintenance operations. The 2000 results of the gas vent monitoring are provided in the table below.

Table 1

Gas vent #	8-17-00	11-9-00
GV-1	0.3	10.4
GV-2	0.6	25.8
GV-3	1.0	20.5
GV-4	5.4	4.9
GV-5	0.4	0.0
GV-6	1.1	13.8
GV-7	17.2	9.3
GV-8	0.2	17.5
GV-9	0.7	16.6
GV-10	2.8	26.0
GV-11	6.2	23.7
GV-12	1.2	26.3
GV-13	0.5	7.8
GV-14	0.2	20.5
GV-15	0.2	5.0
GV-16	0.3	25.0
GV-17	0.3	31.0
GV-18	0.3	26.4
GV-19	3.0	0.0
GV-20	0.2	11.3
GV-21	0.3	0.0
GV-22	0.4	3.0
GV-23	0.3	8.8

There are 16 gas probes surrounding the Landfill to monitor for landfill gas migration from the Landfill. The gas probes were sampled twice during 2001 and the results are provided in Table I. The gas probes on both the west and east side of the Landfill are located very near the waste footprint where gas levels would be expected to be higher. However, the probes closest to the Kummer residence (MS-15) had elevated levels of methane but the Alano Club (MS-16) had levels of methane below 1% by volume indicating that gas migration has not reached a level of concern for that structure.

4,000 trees and shrubs were planted on 11 acres immediately south of the fill along Anne Street in 1998. Trees and shrubs were not planted on the 6 lots west of the site in 1998 as originally planned; however, depending on success rate in the original planting, additional trees and shrubs may be planted on the western 6 lots in the future.

During 2000 several cover system maintenance problems were noted. Several trees had fallen on the western side fence surrounding the property. These were removed and the fence re-attached to the posts. Deer jumping through the fence continue to move the wires so that they need to be re-aligned and re-attached to the posts.

Table 2 - Annual System Operations/O&M Costs

Dates		Total Cost rounded to nearest $1,000
From	**To**	
7/2000	6/2001	$33,750.00

V. Progress Since the Last Five-Year Review

This is the first Five-Year Review for this Site.

VI. Five-year Review Process

Administrative Components

This Five-Year Review Report was written and completed by EPA, based on the technical review of the Site by members of the MPCA staff. This Five-Year Review Report was written by Gladys Beard of EPA.

From November 4, 2001 to February, 2003 the review team established the review schedule whose components included:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection;
- Local Interviews; and
- Five-Year Review Report Development and Review.

The schedule extended through June 2002.

Community Involvement

A notice will be made to the public announcing the completion of the Five-Year Review Report and providing a summary of Five-Year Review findings, protectiveness of the remedy, and advising the community where a copy of the review report can be found. This Five-Year Review Report can be found in the Site's Information Repository.

Document Review

This Five-Year Review consisted of a review of relevant documents including O&M records, monitoring data, and the MPCA's June 30, 2002 report titled "2001 Annual Report." All cleanup standards in the ROD were reviewed.

Data Review

Groundwater Monitoring

Groundwater monitoring has been conducted at the Kummer Landfill since the early 1980s. The feasibility study required the MPCA to review the well advisory area and based upon the hydrogeological data to identify an appropriate buffer zone which would be served by a central water supply system. The MPCA conceptually screened various alternatives to determine which alternatives should be studied further in the feasibility study. The water supply alternatives that the MPCA required to be studied further included the construction of a distribution system.

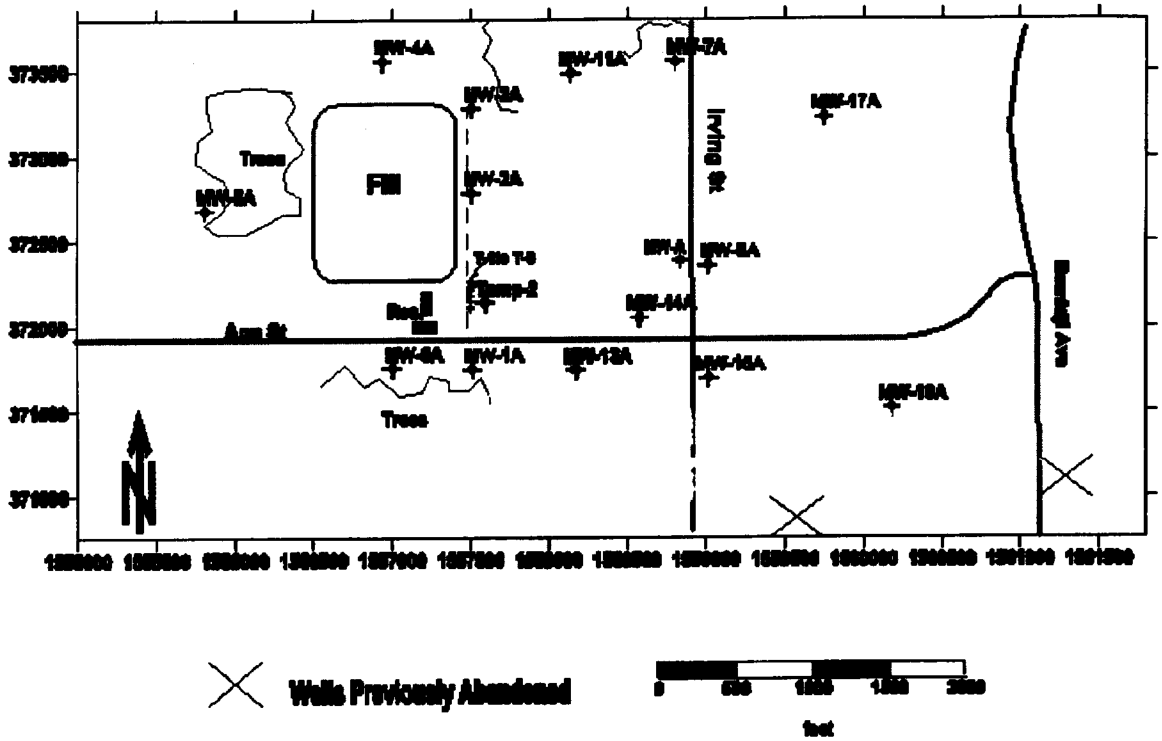
Ground Water Monitoring Summary

Monitoring Well Number	Un. No.	Well Diameter	Well	Pump/ Bailer	Gradient
MW-1A	442479	2 inches	27	Ded Pump	Side/Dn
MW-1B	442480	2 inches	43.0	Ded Pump	Side/Dn
MW-1C	442481	4 inches	62.0	Pump	Side/Dn
**MW-2A	442482	2 inches	25	Ded Pump	Down
**MW-2B	442483	2 inches	36.0	Ded Pump	Down
MW-3A	442484	2 inches	14	Ded Pump	Side/Dn
MW-3B	442485	2 inches	30.0	Ded Pump	Side/Dn
MW-3C	442486	4 inches	45	Pump	Side/Dn

MW-4A	442487	2 inches	17.3	Pump	Side
MW-5A	442488	2 inches	17	Ded Pump	Up
MW-5B	442489	2 inches	35	Ded Pump	Up
MW-5C	442490	4 inches	92	Pump	Up
MW-6A	442491	2 inches	28.6	Pump	Side/Dn
MW-6B	442492	2 inches	47.4	Pump	Side/Dn
MW-7A	442493	2 inches	14	Ded Pump	Side
MW-7B	442494	2 inches	38	Ded Pump	Side
MW-8A	442495	2 inches	22	Pump	Down
MW-11A	438193	2 inches	15	Ded Pump	Side
MW-11B	438192	2 inches	28	Ded Pump	Side
MW-13A	438198	2 inches	15	Ded Pump	Down
**MW-13B	438197	2 inches	47	Ded Pump	Down
MW-14A	438190	2 inches	26.5	Pump	Down
**MW-15A	445476	2 inches	30	Ded Pump	Down
**MW-15B	438200	2 inches	38	Ded Pump	Down
**MW-15C	445480	4 inches	60	Pump	Down
MW-17A	506402	2 inches	15	Ded Pump	Side/Dn
MW-17B	506403	2 inches	30	Ded Pump	Side/Dn
**MW-18A	506404	2 inches	30	Ded Pump	Down
**MW-18B	506405	2 inches	43	Ded Pump	Down
A	04W01001		23.3	Peristaltic	Down
**Temp 1 (N)	582431		49.8	Ded Pump	Down
**Temp 2 (S)	582432		28.7	Ded Pump	Down
*** **Natural Attenuation Wells** --					

Three rounds of water quality samples were collected from all the wells in the monitoring system analyzed for organic, inorganic and natural attenuation parameters by Interpol Laboratories, Inc. (An Interpol) in 2001. This data is presented in Table I (attachment) and the historical sampling stabilization parameters are in Table II (attachment). The landfill monitoring system consists of 32 wells. There are no surface water sampling point or piezometers on- or off-site. The locations of each of the monitoring points are included in the Site diagram (Figure 1) below.

FIGURE 1
KUMMER SANITARY LANDFILL
Site Diagram



Figures 2, 3 and 4 have been prepared to show groundwater elevation data for the shallow, deeper, and deepest wells, respectively. The water levels in shallow monitoring wells remained relatively constant from spring through summer but most wells reflect a slight decrease by November. Review of groundwater data indicates that the groundwater flow direction in the both the surficial and deeper levels of the aquifer were mainly to the east. Based upon the groundwater flow data, there were 3 upgradient wells, 24 downgradient wells and 2 wells that were side gradient to flow from the fill area, while the remainder of the wells are mainly down- or side-gradient. Figures 5a, 5b, and 5c represent the groundwater contours for each horizon of flow in the aquifer during May of 2001. For the shallow flow regime, the horizontal hydraulic gradient during spring was 0.002 and flow was in a mainly easterly direction, becoming east-northeasterly to the east of the landfill (Figure 5a). This gradient remained essentially constant with depth (Figure 5b), decreasing only slightly in the deepest level of the aquifer, the C-horizon, with a gradient of 0.0016 (Figure 5c). Notice that although groundwater continued to move easterly, there were east-southeast and east-northeast components added with depth, perhaps reflecting a heterogeny within the aquifer at those levels or a mounding effect at depth. During September 2002, the shallow bi-directional flow across the landfill became slightly less pronounced (Figure 6a), while a more east-southeast flow direction increased with depth (Figures 6b and 6c). The gradients remained relatively consistent in the shallow and deep flow regimes but decreased steadily in wells reflecting the deepest flow. There was no coordination of gradients with the fluctuation of water levels during 2000; the levels decreased in summer but increased to levels slightly higher than those seen in spring (Figure 3). During December 2001, gradients from shallow to deepest decreased the most, with a gradient of 0.0013 in C-horizon wells (Figures 7a, 7b, and 7c). The direction of flow, however, became more east-northeasterly in both the A-horizon and B-horizon wells, while the C-horizon (deepest) wells flowed strongly southeasterly across the entire site.

Vertical gradients were variable for some of the wells with flow moving upward and downward at different times during the year. The table below lists the values, with a positive number indicating downward movement and a negative number upward movement.

Vertical Gradient calculated for the well nests

[illegible]	[illegible]	AUGUST	DECEMBER
MW-1A/1B	0.010	0.017	Not measured
MW-1B/1C	-0.018	-0.017	-0.017
MW-2A/2B	-0.065	0.009	0.006
MW-3A/AB	-0.008	0.031	0.032
MW-3B/3C	0.013	-0.050	-0.044
MW-5A/5B	0.006	0.006	Not measured
MW-5B/5C	0.011	0.010	0.009
MW-6A/6B	0.007	0.008	0.009
MW-7A/7B	-0.062	-0.086	-0.075
MW-11A/11B	-0.070	-0.073	-0.067
MW-13A/13B	0.014	0.005	0.005
MW-15A/15B	0.020	0.039	0.032
MW-15B/15C	0.024	-0.028	-0.033
MW-17A/17B	-0.142	-0.138	-0.138
MW-18A/18B	0.005	0.007	0.005
TEMP 1/TEMP 2	0.008	0.009	0.005

These numbers verify that water moves consistently from B-horizon to A-horizon in the northern portion of the monitoring system, east-northeast of the landfill (well nests 7, 11, and 17), except for well nest 3, which changes flow direction from spring (upward) to summer and fall (downward). Notice how the gradients become stronger the further hydraulically downgradient the water flows (see Figure 1 for well locations), most probably due to the influence of Lake Bemidji in the regional water flow. Examination of well nests to the east, south and southeast indicates consistent downward movement of water (well nests 1, 5, 6, 13 15, and 18), except for well nest 2, which exhibits upward flow direction during spring before changing to downward flow in summer and fall. Flow between deepest wells (C-horizon) and B-horizon are as follows: continual downward vertical gradient at the upgradient well nest 5, upward flow gradient at well nest 1, but well nests 3 and 15 reflect downward flow in spring that changes to upward flow by summer and continuing through fall. The strongest gradients are seen at well nest 17, between A- and B-horizon wells with upward gradients throughout the year. See Figure 11 for a pictorial representation of the flow directions. Flow between the horizons is represented by either an upward or downward arrow, with one arrow for each monitoring period. Red arrows indicate A- / B-horizon flow and black arrows represent flow between B- / C-horizons. Note the downward gradients in monitoring wells to the southeast explain deeper contamination seen in B-horizon wells (Figure 9), while upward flow tends to explain contamination seen in shallow wells northeast of the landfill (Figure 8).

The water quality analytical data obtained from the sampling events is divided into organic and inorganic sets and is presented in Table I (attachment), with sampling stabilization parameters in Table II (attachment). Figure 8 indicates total VOCs in A-Horizon (shallow) wells closest to the fill (MW-2A and MW-3A) have decreased since 2000 mainly due to decreases in ethyl ether. VOCs in the rest of the shallow wells mainly continue to decrease, except for MW 11A and MW-17A, which have increased levels of dichlorodifluoromethane of approximately 4 – 5 ug/L (Table I). Total VOCs in deep wells (B-Horizon) remain stable, except for MW-2B, which reflects a large decrease in ethyl ether and dichlorodifluoromethane (Figure 9). The tetrahydrofuran spike seen in MW-2B during 2000 was unsupported by further sampling (Table I). Vinyl chloride levels in most wells remains low but there has been a slight increase in most wells, especially MW-17B, MW-11A, and MW-3B, over the year (Figure 11). Sampling during 2002 will confirm whether this trend will continue.

Site Inspection

Regular inspections related to the landfill conditions were completed during 2001 and 2002. There was a site inspection conducted in September 2002. No major issues were identified in these inspections. Site inspections take place on a regular basis and will continue on a long-term basis.

Interviews

In processing this report U.S. EPA interviewed the MPCA to obtain information. None of MPCA staff was able to identify any concerns regarding the Site and there had not been any emergency responses at the Site.

VII. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

The review of documents, ARARS, risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the ROD. The stabilization and capping of the contaminated landfill has achieved the remedial objectives to minimize contaminants to groundwater and surface water and prevent direct contact with, or ingestion of, contaminants in soil and groundwater. The effective implementation of institutional controls has prevented exposure to, or ingestion of, contaminated groundwater.

Operation and maintenance (O.M.) of the cap and groundwater have been effective. O.M. annual costs are consistent with original estimates and there are no indications of any difficulties with the remedy.

No activities were observed that would have violated the institutional controls. The cap and the surrounding area were undisturbed, and no new uses of groundwater were observed. The fence around the Site is intact and in good repair.

Question B: Are the exposure assumptions, toxicity data cleanup levels and remedial action objectives (rads) used at the time of the remedy selection still valid?

Changes in Exposure Pathways, Toxicity, and Other Contaminant Characteristics

The exposure assumptions used to develop the Human Health Risk Assessment included both current exposures (older child trespasser, adult trespasser) and potential future exposures (young and older future child resident, future adult resident and future adult worker). There have been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessment. These assumptions are considered to be conservative and reasonable in evaluating risk and developing risk-based cleanup levels. No change to these assumptions, or the cleanup levels developed from them is warranted. There has been no change to the standardized risk assessment methodology that could affect the protectiveness of the remedy. The remedy is progressing as expected and it is expected that all groundwater cleanup levels will be met within approximately the time frame stated in the ROD.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

No ecological targets were identified during the baseline risk assessment and none were identified during the five-year review, and therefore monitoring of ecological targets is not necessary. All groundwater and surface water samples analyzed found no contamination of wetlands or surface water. No weather-related events have affected the protectiveness of the remedies. There is no other information that calls into question the protectiveness of the remedies. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Technical Assessment Summary

According to the data reviewed, the site inspection, and the interviews, the remedies are functioning as intended by the ROD. There are no changes in the physical conditions of the site that would affect the protectiveness of the remedy. There has been no changes in the toxicity factors for the contaminants of concern that were used in the baseline risk assessment, and there have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedies. There is no other information that calls into question the protectiveness of the remedies.

VIII. Issues

Table 3 - Issues

Issue	Currently Affects Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Continue with routine site maintenance including annual mowing of the vegetative cover and site inspections of the cover's integrity.	N	N
Continue monitoring gas probe network around the landfill during 2003.	N	N
Continue routine site maintenance	N	N
Evaluate potential migration of groundwater contaminants	N	N
Continue with groundwater and surface water sampling program.	N	N

IX. Recommendations and Follow-Up Actions

Table 4 - Recommendations and Follow-Up Actions

Issue	Recommendations Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
					Current	Future
Evaluate potential migration of ground water contaminants Continue long-term monitoring with the collection of natural attenuation parameters along the centerline of the plume.	Additional sampling and ground water analysis	PRPs	State	Within the next 6 months	N	Y
Continue with routine site Maintenance	Annual mowing to the cover, site inspection and groundwater	PRPs	State	Annually	N	N
Continue monitoring gas probe network around the landfill during 2003.	Monitoring to detect migration of landfill gas and thereby evaluate the effectiveness of the active gas system	PRPs	State	2003	N	N

X. Protectiveness Statement

The remedy is protective in the short-term of human health and the environment. All immediate threats at the site have been addressed. All threats at the Site have been addressed through stabilization and capping of contaminated soil and sediments, the installation of fencing and warning signs, and the implementation of institutional controls.

Long-term protectiveness of human health and the environment will be achieved upon attainment of groundwater cleanup goals, through natural attenuation. In the interim, exposure pathways that could result in unacceptable risks are being controlled and institutional controls are preventing exposure to, or the ingestion of, contaminated groundwater.

Long-term protectiveness of the remedial action will be verified by obtaining additional groundwater samples to fully evaluate potential migration of the contaminants. Current monitoring data indicate that the remedy is functioning as required to achieve groundwater cleanup goals.

X. Next Review

The next five-year review for the Site is required by March 2008, five years from the date of this review.

TABLE I HISTORICAL GAS PROBE MONITORING DATA

(percent by volume unless otherwise stated)

Date	MS-1 D	MS-2 E	MS-3 G	MS-4 H	MS-5 I	MS-6 J	MS-7 K	MS-8	MS-9 L	MS-10 A	MS-11 B	MS-12 C	MS-13 M	MS-14 F	MS-15 P	MS-16 O	MS-17 N
10/14/92	NT	NT	NT	NT	NT	NT	55	38	59	60	30	NT					
1/19/1993	0	37	57	69	0.3	31	33	23	58	46	0.3	0					
5/26/1993	0	80% LEL	100% LEL	100% LEL	0	100% LEL	50% LEL	0	100% LEL	1% LEL	65% LEL	0	0				
11/18/1993	0	0.1	57.3	41	0.3	1.1	10	0.2	48.1	16.5	3.1	0.2	0.3				
10/1/1994	0	0	0	0.2	0.5	0	10.7	35	35.2	0	0.1	0	0	0	0		
10/14/1994	0	0	0	0	0.1	0.1	9.7	37.2	36.7	0	0	0	0	0.1	0		
11/21/1994	0	0	1.8	0	0	0	4.7	1.6	28	0	0	0	0	0	0	0	
1/24/1995	0.6	0.9	7.1	0.4	0	0.2	0.5	0.5	37.1	0.4	0.3	1	0.3	0.6	0.2	0.2	
2/16/1995	0	0.1	8.5	0	0	0	0.1	0.1	35.5	0.2	0.3	0.1	0	0.1	0	0	
2/16/1999	0	0	66.7	28.6	0	0	0	0	45.9	0	0	0	-	66.6	NF	0	0
5/6/1999	0.3	0.1	59.9	25.8	0.2	0.2	0.9		41	0.1	0.7	0.2	0.2	58	NF	0.1	0.2
7/30/1999	0.2	1.2	65.2	0.3	0.2	NT?	17.1		51.6	10.2	0.3	0.3	0.1	73.2	NF	0.1	31.4
10/27/1999	0.1	0.6	63.1	3.8	0.1	0.4	13.3		50	5.2	0.3	0.2	0.1	62.9	NF	0.1	18.1
4/13/2000*	0.1	0.1	30.7	19	0.2	0.2	0.4		21.9	0	0	0		47.9	0.1	0.9	0
8/17/2000*	0.1	0.2	57.3	33.7	0.2	0.2	0.3		0.2	0	0.1	0.2		44.8	26.7	0.2	0.2
11/9/2000*	0	0	55.7	47.6	0	0.1	6.4		8.2	0	6	0		62.9	41.3	0	0
5/2/2001*	0	0	55.1	20	0	0	3.6		1.9	0	0	0		43.3	30.6	0	0
9/17/2001*	0	0	63.7	47.9	0	0.1	0		4.1	0	0	0		61.3	41	0.1	0.1
3/7/2002	0.2	0	41.2	11.4	0	0	0		34.7	0	0	0	0	52.9	0	0	0
4/30/2002	0	0	30.9	10.7	0	0	0		15.9	0	0	0	0	35.2	0	0	0
7/31/2002	0	0	54.1	34.2	0	0	0.9		30.3	0	0	0	0	49.2	0	0	8.8
*** 3 minutes**																	

TABLE II -- STABILIZATION PARAMETERS

UNIQUE WELL NUMBER	WELL NUMBER	SAMPLE DATE	DISSOLVE OXYGEN	FIELD TURBID	SPECIFIC CONDUCT	FIELD pH	TEMP deg C	PUMP / BAIL	PUMP RATE	GALLONS REMOVE	Well Vol (gal)	STATIC BEFORE	STATIC AFTER	WELL DEPTH	Eh
442479	MW-1A	4-Apr-00	10.30	7.4	846	7.02	7.90	Ded. B. Pump	0.30	3.6	0.81	> 22.17	> 22.17	**27.00**	217
442479	MW-1A	9-Aug-00	8.10	5.2	593	7.23	10.80	Ded. B. Pump	0.20	4	0.80	22.10	22.10	**27.00**	74
442479	MW-1A	2-May-01	0.70	3.24	943	6.44	8.00	Ded. B. Pump	0.20	2.4	0.73	22.40	NA	**27.00**	-37
442479	MW-1A	19-Sep-01	7.14	3.05	1011	7.01	8.46	Ded. B. Pump	0.20	3.2	0.76	22.24	22.24	**27.00**	74
442480	MW-1B	4-Apr-00	0.21	0.7	457	6.90	8.40	Ded. B. Pump	0.75	11.25	3.3	22.44	22.44	**43.00**	-77
442480	MW-1B	9-Aug-00	< 0.1	1.4	613	6.95	9.00	Ded. B. Pump	0.75	11.25	3.26	22.98	22.98	**43.00**	21
442480	MW-1B	8-Nov-00	0.21	1.4	778	6.81	8.21	Ded. B. Pump	0.75	11.25	3.33	22.62	22.62	**43.00**	-77
442480	MW-1B	2-May-01	0.37	1.91	617	6.54	8.74	Ded. B. Pump	0.75	11.25	3.3	22.54	22.54	**43.00**	-67
442480	MW-1B	19-Sep-01	0.18	2.26	674	6.96	8.68	Ded. B. Pump	0.75	11.25	3.3	22.41	22.41	**43.00**	-17
442480	MW-1B	29-Nov-01	0.21	2.7	349	6.91	8.21	Ded. B. Pump	0.75	11.25		22.73	22.73	**43.00**	-36
442481	MW-1C	4-Apr-00	0.13	1	350	7.07	8.20	Ded. B. Pump	0.75	78.75	25.8	22.52	22.52	**62.00**	-109
442481	MW-1C	9-Aug-00	0.10	1.4	400	7.34	8.60	Ded. B. Pump	0.75	76.5	25.6	23.09	23.09	**62.00**	-89
442481	MW-1C	8-Nov-00	0.16	1.2	523	7.11	8.23	Ded. B. Pump	0.75	78.75	25.64	22.74	22.74	**62.00**	-127
442481	MW-1C	19-Sep-01	0.21	0.56	446	7.30	8.46	Ded. B. Pump	0.75	76.5	25.6	22.53	22.53	**62.00**	-122
442481	MW-1C	29-Nov-01	0.18	1.7	291	7.16	8.15	Ded. B. Pump	0.75	76.5		22.85	22.85	**62.00**	-49
442482	MW-2A	6-Apr-00	0.21	2.7	517	7.02	7.60	Ded. B. Pump	0.30	4.5	1.5	15.76	15.76	**25.00**	-72
442482	MW-2A	10-Aug-00	0.10	0.67	524	6.81	9.70	Ded. B. Pump	0.30	4.5	1.4	16.32	16.32	**25.00**	-71
442482	MW-2A	9-Nov-00	0.18	0.7	869	6.73	9.68	Ded. B. Pump	0.30	4.5	1.5	15.71	15.71	**25.00**	-109
442482	MW-2A	3-May-01	0.08	7.61	900	6.21	7.32	Ded. B. Pump	0.30	5.4	1.53	15.41	15.41	**25.00**	-92
442482	MW-2A	20-Sep-01	0.22	0.2	855	6.78	9.50	Ded. B. Pump	0.30	4.5	1.4	15.96	15.96	**25.00**	-97
442482	MW-2A	1-Dec-01	0.27	1.9	344	6.84	9.41	Ded. B. Pump	0.30	4.5		16.11	16.11	**25.00**	-32
442483	MW-2B	6-Apr-00	0.12	1.6	586	7.20	8.30	Ded. B. Pump	0.75	11.25	3.3	15.78	15.78	**36.00**	-79
442483	MW-2B	10-Aug-00	< 0.1	0.72	509	7.04	8.90	Ded. B. Pump	0.75	11.25	3.2	16.37	16.37	**36.00**	-117
442483	MW-2B	9-Nov-00	6.03	1	1075	6.68	8.36	Ded. B. Pump	0.50	10.5	3.31	15.73	15.74	**36.00**	-117
442483	MW-2B	3-May-01	0.09	2.79	1027	6.30	8.33	Ded. B. Pump	0.50	10.5	3.45	14.45	14.45	**36.00**	-112
442483	MW-2B	20-Sep-01	0.14	2.71	1020	6.86	8.40	Ded. B. Pump	0.75	11.25	3.2	16.03	16.03	**36.00**	-130
442483	MW-2B	1-Dec-01	0.19	1.7	297	7.07	8.21	Ded. B. Pump	0.75	11.25		16.15	16.15	**36.00**	-71
442484	MW-3A	4-Apr-00	0.20	4.3	631	6.74	4.70	Ded. B. Pump	0.20	3	0.60	10.49	10.50	**14.00**	-127
442484	MW-3A	9-Aug-00	0.20	2.6	663	6.62	12.50	Ded. B. Pump	0.20	2.4	0.65	10.00	10.00	**14.00**	-65
442484	MW-3A	8-Nov-00	0.41	0.9	1221	6.48	9.80	Ded. B. Pump	0.20	2.4	0.63	10.15	10.15	**14.00**	-102
442484	MW-3A	2-May-01	0.19	7.14	881	6.42	4.21	Ded. B. Pump	0.20	2.4	0.63	10.07	10.07	**14.00**	-97
442484	MW-3A	18-Sep-01	0.21	4.11	1065	6.57	12.49	Ded. B. Pump	0.20	1.8	0.63	10.25	10.25	**14.00**	-106

TABLE II -- STABILIZATION PARAMETERS

UNIQUE WELL NUMBER	WELL NUMBER	SAMPLE DATE	DISSOLVE OXYGEN	FIELD TURBID	SPECIFIC CONDUCT	FIELD pH	TEMP deg C	PUMP / BAIL	PUMP RATE	GALLONS REMOVE	Well Vol (gal)	STATIC BEFORE	STATIC AFTER	WELL DEPTH	Eh
442484	MW-3A	29-Nov-01	0.82	3.1	461	6.57	8.59	Ded. B. Pump	0.20	1.8		10.30	10.30	**14.00**	-17
442485	MW-3B	4-Apr-00	0.11	0.87	449	7.14	7.40	Ded. B. Pump	0.45	10.8	3.3	10.02	10.02	**30.00**	-139
442485	MW-3B	9-Aug-00	< 0.1	3.2	560	7.30	8.60	Ded. B. Pump	0.45	9.45	3.1	10.70	10.70	**30.00**	-121
442485	MW-3B	8-Nov-00	0.20	1.2	694	7.13	8.30	Ded. B. Pump	0.45	10.8	3.3	10.01	10.01	**30.00**	-150
442485	MW-3B	2-May-01	0.21	1.79	453	7.49	6.91	Ded. B. Pump	0.45	10.8	3.3	9.47	9.47	**30.00**	-152
442485	MW-3B	18-Sep-01	0.15	1.55	592	7.37	8.50	Ded. B. Pump	0.45	9.45	3.14	10.36	10.36	**30.00**	-181
442485	MW-3B	29-Nov-01	0.17	2.3	361	7.19	8.24	Ded. B. Pump	0.45	9.45		10.43	10.43	**30.00**	52
442486	MW-3C	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		9.92	NA	**NA**	NA
442486	MW-3C	9-Aug-00	0.10	2.4	337	7.65	8.30	Ded. B. Pump	0.60	19.8	6.5	10.53	10.53	**45.00**	-59
442486	MW-3C	18-Sep-01	0.11	1.19	357	7.62	7.99	Ded. B. Pump	0.60	19.8	6.5	10.05	10.05	**45.00**	-47
442487	MW-4A	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		9.58	NA	**NA**	NA
442487	MW-4A	9-Aug-00	0.20	1.4	400	7.25	14.00	B. Pump	0.40	3.6	1.1	10.38	10.38	**17.30**	46
442487	MW-4A	8-Nov-00	0.69	1.9	523	7.31	7.93	B. Pump	0.40	4.8	1.3	9.32	9.32	**17.30**	-35
442487	MW-4A	18-Sep-01	0.41	1.28	389	7.38	13.21	B. Pump	0.40	3.6	1.16	10.05	10.05	**17.30**	-41
442487	MW-4A	29-Nov-01	1.83	1.74	315	7.53	6.76	Ded. B. Pump	0.40	4.8		10.04	10.04	**17.30**	112
442488	MW-5A	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		12.30	NA	**NA**	NA
442488	MW-5A	9-Aug-00	5.10	2	296	7.60	9.60	Ded. B. Pump	0.40	2.4	0.76	12.30	12.30	**17.00**	112
442488	MW-5A	18-Sep-01	5.05	1.06	336	7.48	10.17	Ded. B. Pump	0.40	3.2	7.3	12.40	12.40	**17.00**	29
442489	MW-5B	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		12.74	NA	**NA**	NA
442489	MW-5B	9-Aug-00	< 0.1	5.1	354	7.68	8.30	Ded. B. Pump	0.45	10.8	3.5	13.29	13.29	**35.00**	-131
442489	MW-5B	18-Sep-01	0.18	5.01	401	7.58	7.87	Ded. B. Pump	0.45	10.8	3.54	12.86	12.86	**35.00**	-185
442490	MW-5C	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		12.88	NA	**NA**	NA
442490	MW-5C	9-Aug-00	0.10	1.7	320	7.64	8.30	Ded. B. Pump	0.45	18.9	6.5	13.55	13.56	**92.00**	-42
442490	MW-5C	18-Sep-01	0.12	0.85	355	7.59	7.78	Ded. B. Pump	0.45	18.9	6.5	13.04	13.04	**92.00**	-17
442491	MW-6A	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		22.62	NA	**NA**	NA
442491	MW-6A	9-Aug-00	8.10	8.1	509	7.29	7.80	B. Pump	0.40	6	0.87	23.15	23.16	**28.50**	201
442491	MW-6A	18-Sep-01	6.23	5.03	701	7.29	7.98	B. Pump	0.40	4.8	0.94	22.57	22.57	**28.50**	72
442492	MW-6B	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		22.56	NA	**NA**	NA
442492	MW-6B	9-Aug-00	0.30	4.2	403	7.35	8.50	B. Pump	0.50	12	4	23.10	23.10	**47.50**	57
442492	MW-6B	18-Sep-01	0.51	4.91	479	7.33	8.20	B. Pump	0.50	12	4	22.52	22.52	**47.50**	-17

TABLE II -- STABILIZATION PARAMETERS

UNIQUE WELL NUMBER	WELL NUMBER	SAMPLE DATE	DISSOLVE OXYGEN	FIELD TURBID	SPECIFIC CONDUCT	FIELD pH	TEMP deg C	PUMP / BAIL	PUMP RATE	GALLONS REMOVE	Well Vol (gal)	STATIC BEFORE	STATIC AFTER	WELL DEPTH	Eh
442493	MW-7A	4-Apr-00	0.40	1.7	478	7.13	4.50	Ded. B. Pump	0.40	6	1.75	3.26	3.26	14.00	186
442493	MW-7A	10-Aug-00	2.60	2.1	433	7.09	9.60	Ded. B. Pump	0.40	4.8	1.56	4.45	4.45	14.00	97
442493	MW-7A	9-Nov-00	0.27	1.4	718	6.97	9.99	Ded. B. Pump	0.40	6	1.78	3.11	3.12	14.00	-53
442493	MW-7A	3-May-01	0.94	4.92	699	6.53	5.20	Ded. B. Pump	0.40	6	1.72	3.24	3.24	14.00	51
442493	MW-7A	18-Sep-01	0.16	0.47	802	6.92	11.42	Ded. B. Pump	0.40	4.8	1.6	4.02	4.02	14.00	-29
442493	MW-7A	29-Nov-01	0.21	1.7	341	6.96	9.51	Ded. B. Pump	0.40	4.8		3.80	3.80	14.00	-49
442494	MW-7B	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		2.15	NA	NA	NA
442494	MW-7B	10-Aug-00	1.00	1.9	291	7.74	8.00	Ded. B. Pump	0.90	18.9	5.8	2.61	2.61	38.00	72
442494	MW-7B	18-Sep-01	0.13	3.96	362	7.70	7.77	Ded. B. Pump	0.90	18.9	5.78	1.89	1.89	38.00	-95
442495	MW-8A	6-Apr-00	0.39	1.7	267	7.42	7.40	Grundfos	0.75	11.25	3.78	17.02	17.02	40.20	17
442495	MW-8A	10-Aug-00	0.10	0.71	348	7.36	9.10	B. Pump	0.75	11.25	3.7	17.27	17.27	40.00	-79
442495	MW-8A	10-Nov-00	0.13	1.7	526	7.55	7.84	B. Pump	0.75	11.25	3.8	16.73	16.73	40.00	-120
442495	MW-8A	4-May-01	0.14	2.65	350	6.81	8.52	B. Pump	0.75	11.25	3.73	16.71	16.71	40.00	-111
442495	MW-8A	20-Sep-01	0.12	1.15	427	7.33	8.43	B. Pump	0.75	11.25	3.70	16.89	16.89	40.00	-117
442495	MW-8A	30-Nov-01	0.22	1.4	227	7.34	8.41	Ded. B. Pump	0.75	11.25		17.15	17.23	40.00	-12
438193	MW-11A	4-Apr-00	0.93	6.1	380	7.02	3.90	Ded. B. Pump	0.45	9	1.4	6.36	6.36	15.00	112
438193	MW-11A	10-Aug-00	0.20	3.2	413	6.88	9.70	Ded. B. Pump	0.50	7.5	1.3	7.23	7.23	15.00	27
438193	MW-11A	9-Nov-00	4.44	4.4	612	6.78	8.56	Ded. B. Pump	0.50	6	1.43	6.23	6.23	15.00	-33
438193	MW-11A	3-May-01	0.31	4.97	521	6.45	3.81	Ded. B. Pump	0.40	8	1.4	6.24	6.24	15.00	-52
438193	MW-11A	19-Sep-01	0.21	2.82	794	6.81	11.39	Ded. B. Pump	0.50	4.5	1.3	7.08	7.08	15.00	12
438193	MW-11A	30-Nov-01	1.01	3.7	291	6.83	7.74	Ded. B. Pump	0.40	4.8		6.94	6.94	15.00	29
438192	MW-11B	4-Apr-00	0.14	1.4	357	742.00	7.50	Ded. B. Pump	0.75	15	3.8	4.70	4.72	28.00	12
438192	MW-11B	10-Aug-00	0.10	0.9	367	7.32	7.80	Ded. B. Pump	0.75	11.25	3.7	5.53	5.53	28.00	-81
438192	MW-11B	9-Nov-00	0.19	1.1	590	7.18	8.09	Ded. B. Pump	0.75	13.5	3.8	4.53	4.53	28.00	-124
438192	MW-11B	3-May-01	0.22	1.63	527	6.74	7.07	Ded. B. Pump	0.75	11.25	3.8	4.38	4.39	28.00	-87
438192	MW-11B	19-Sep-01	0.11	0.61	553	7.37	8.17	Ded. B. Pump	0.75	11.25	3.6	5.18	5.18	28.00	-136
438192	MW-11B	30-Nov-01	0.19	1.6	256	7.35	8.22	Ded. B. Pump	0.75	11.25		5.12	5.12	28.00	-72
438198	MW-13A	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		10.90	NA	NA	NA
438198	MW-13A	10-Aug-00	3.80	14.1	472	6.92	12.50	Ded. B. Pump	0.25	3.75	0.68	10.80	10.80	15.00	249
438198	MW-13A	19-Sep-01	3.99	4.96	807	6.80	13.61	Ded. B. Pump	0.25	3	0.68	10.77	10.78	15.00	95
438197	MW-13B	5-Apr-00	0.21	1.3	536	7.03	8.30	Ded/Packer	0.40	4.8	1.6	10.94	10.94	47.00	111
438197	MW-13B	10-Aug-00	0.20	1	420	6.97	9.50	Ded. B. Pump	0.40	4.8	1.6	11.39	11.39	47.00	213

TABLE II -- STABILIZATION PARAMETERS

UNIQUE WELL NUMBER	WELL NUMBER	SAMPLE DATE	DISSOLVE OXYGEN	FIELD TURBID	SPECIFIC CONDUCT	FIELD pH	TEMP deg C	PUMP / BAIL	PUMP RATE	GALLONS REMOVE	Well Vol (gal)	STATIC BEFORE	STATIC AFTER	WELL DEPTH	Eh	
438197	MW-13B	9-Nov-00	3.61	1.7	698	7.03	8.52	Ded. B. Pump	0.40	4.8	1.6	10.64	10.64	**47.00**	100	
438197	MW-13B	3-May-01	0.36	1.14	651	6.69	8.87	Ded. B. Pump	0.40	4.8	1.6	10.94	10.94	**47.00**	17	
438197	MW-13B	19-Sep-01	0.71	0.96	749	6.91	9.31	Ded. B. Pump	0.40	4.8	1.6	10.62	10.62	**47.00**	83	
438197	MW-13B	29-Nov-01	3.96	2	332	7.08	8.37	Ded. B. Pump	0.40	4.8		11.16	11.16	**47.00**	125	
438190	MW-14A	4-Apr-00	NA	NA	NA	NA	NA	NA	NA	NA		23.26	NA	**NA**	NA	
438190	MW-14A	9-Aug-00	1.70	3.9	478	6.93	10.50	B. Pump	0.25	3	0.51	23.61	23.61	**26.70**	183	
438190	MW-14A	8-Nov-00	2.78	4.7	747	7.04	8.47	B. Pump	0.20	3	0.56	23.26	23.32	**26.70**	103	Ded Eqipment installed
438190	MW-14A	3-May-01	0.70	4.73	594	6.65	8.15	Ded. B. Pump	0.20	3	0.56	23 20	Top of Pump	**26.70**	12	
438190	MW-14A	19-Sep-01	4.53	5.43	564	7.14	10.51	Ded. B. Pump	0.25	3	0.80	21.65	21.65	**26.70**	29	
438190	MW-14A	29-Nov-01	5.47	7.4	317	7.14	8.27	Ded. B. Pump	0.25	3		21.65	21.65	**26.70**	102	
445476	MW-15A	5-Apr-00	4.60	4.2	648	7.30	8.00	Ded. B. Pump	0.40	4.8	1.4	21.40	21.40	**30.00**	245	
445476	MW-15A	11-Aug-00	0.90	4.3	616	7.25	8.70	Ded. B. Pump	0.40	4.8	1.4	21.64	21.64	**30.00**	81	
445476	MW-15A	10-Nov-00	4.61	2.1	785	7.25	8.67	Ded. B. Pump	0.40	4.8	1.37	21.62	21.62	**30.00**	41	
445476	MW-15A	19-Sep-01	7.39	1.17	669	7.30	8.48	Ded. B. Pump	0.40	4.8	1.4	21.42	21.42	**30.00**	49	
438200	MW-15B	5-Apr-00	3.10	5.1	617	7.35	8.30	Ded. B. Pump	0.40	14	2.6	21.80	21.80	**38.00**	262	
438200	MW-15B	11-Aug-00	0.60	4.9	692	7.20	8.80	Ded. B. Pump	0.40	8.4	2.6	22.10	22.10	**38.00**	21	
438200	MW-15B	10-Nov-00	2.99	2.4	749	7.37	8.05	Ded. B. Pump	0.40	8.4	2.74	21.22	21.23	**38.00**	21	
438200	MW-15B	4-May-01	0.40	8.51	572	6.99	8.49	Ded. B. Pump	0.40	11.2	2.6	21.95	21.95	**38.00**	41	
438200	MW-15B	19-Sep-01	1.19	2.25	736	7.21	8.06	Ded. B. Pump	0.40	8.4	2.6	21.90	21.90	**38.00**	21	
438200	MW-15B	30-Nov-01	2.97	1.6	314	7.27	8.10	Ded. B. Pump	0.40	8.4		22.21	22.21	**38.00**	114	
445480	MW-15C	5-Apr-00	1.10	9.3	328	7.51	7.80	Ded. B. Pump	0.30	26.4	6.5	21.18	34.41	**60.00**	128	
445480	MW-15C	11-Aug-00	0.90	1.1	371	7.78	9.00	Ded. B. Pump	0.30	19.8	6.5	21.53	30.43	**60.00**	45	
445480	MW-15C	10-Nov-00	0.23	3.2	417	8.26	7.96	Ded. B. Pump	0.30	19.8	6.5	21.14	26.79	**60.00**	-114	
445480	MW-15C	4-May-01	0.73	2.17	347	7.67	8.24	Ded. B. Pump	0.30	19.8	6.5	22.10	24.17	**60.00**	12	
445480	MW-15C	19-Sep-01	0.16	4.93	439	7.40	8.44	Ded. B. Pump	0.30	19.8	6.6	21.03	24.71	**60.00**	-78	
445480	MW-15C	30-Nov-01	0.24	2.1	236	7.45	7.83	Ded. B. Pump	0.30	19.8		21.25	25.16	**60.00**	-12	
506402	MW-17A	4-Apr-00	0.17	1.2	342	7.36	5.60	Ded. B. Pump	0.45	6.75	1.9	3.42	3.46	**15.00**	15	
506402	MW-17A	10-Aug-00	0.19	0.56	372	7.30	10.50	Ded. B. Pump	0.45	5.4	1.5	5.59	5.59	**15.00**	21	
506402	MW-17A	9-Nov-00	0.17	1	559	7.21	9.35	Ded. B. Pump	0.45	5.4	1.6	4.99	4.99	**15.00**	-63	
506402	MW-17A	3-May-01	0.37	1.93	511	6.76	5.73	Ded. B. Pump	0.45	5.4	1.6	5.12	5.12	**15.00**	-39	
506402	MW-17A	19-Sep-01	0.22	0.83	594	7.27	11.77	Ded. B. Pump	0.45	5.4	1.5	5.45	5.45	**15.00**	11	
506402	MW-17A	30-Nov-01	0.22	1.4	294	7.24	8.55	Ded. B. Pump	0.45	5.4		5.34	5.34	**15.00**	17	

TABLE II -- STABILIZATION PARAMETERS

UNIQUE WELL NUMBER	WELL NUMBER	SAMPLE DATE	DISSOLVE OXYGEN	FIELD TURBID	SPECIFIC CONDUCT	FIELD pH	TEMP deg C	PUMP / BAIL	PUMP RATE	GALLONS REMOVE	Well Vol (gal)	STATIC BEFORE	STATIC AFTER	WELL DEPTH	Eh
506403	MW-17B	4-Apr-00	0.11	5.21	382	7.33	7.70	Ded. B. Pump	0.60	12.6	4.1	4.69	4.70	30.00	51
506403	MW-17B	10-Aug-00	0.11	1.1	375	7.31	9.30	Ded. B. Pump	0.60	12.6	4	5.23	5.23	30.00	-47
506403	MW-17B	9-Nov-00	0.20	1.5	611	7.13	7.89	Ded. B. Pump	0.60	12.6	4.16	4.53	4.53	30.00	-89
506403	MW-17B	3-May-01	0.29	4.44	513	6.69	7.45	Ded. B. Pump	0.60	12.6	4	4.70	4.70	30.00	-42
506403	MW-17B	19-Sep-01	0.14	3.16	562	7.33	9.40	Ded. B. Pump	0.40	12	3.98	5.09	5.09	30.00	-97
506403	MW-17B	30-Nov-01	0.19	2	267	7.24	8.32	Ded. B. Pump	0.35	12.6		4.98	4.98	30.00	-110
506404	MW-18A	5-Apr-00	7.10	2.7	389	7.52	7.60	Ded. B. Pump	0.30	3.6	1.1	23.13	23.13	30.00	317
506404	MW-18A	10-Aug-00	8.00	2.1	375	7.46	8.60	Ded. B. Pump	0.30	3.6	1.1	23.04	23.04	30.00	220
506404	MW-18A	3-May-01	0.57	2.13	452	6.95	7.79	Ded. B. Pump	0.30	3.6	1.2	22.64	22.24	30.00	62
506404	MW-18A	18-Sep-01	6.81	1.91	498	7.44	8.93	Ded. B. Pump	0.30	3.6	1.2	22.85	22.85	30.00	72
506405	MW-18B	5-Apr-00	6.20	1.3	418	7.46	8.40	Ded. B. Pump	0.60	10.8	3.2	23.14	23.14	43.00	294
506405	MW-18B	10-Aug-00	2.10	2.7	447	7.25	8.40	Ded. B. Pump	0.60	10.8	3.2	23.09	23.09	43.00	179
506405	MW-18B	9-Nov-00	5.53	1.1	646	7.00	7.63	Ded. B. Pump	0.60	10.8	3.3	22.59	22.59	43.00	117
506405	MW-18B	3-May-01	1.03	1.89	555	6.81	8.42	Ded. B. Pump	0.60	10.8	3.2	22.66	22.66	43.00	52
506405	MW-18B	18-Sep-01	7.31	4.17	569	7.30	7.93	Ded. B. Pump	0.60	10.8	3.2	22.89	22.89	43.00	67
506405	MW-18B	29-Nov-01	5.92	2.6	316	7.27	7.49	Ded. B. Pump	0.60	10.8		23.16	23.16	43.00	42
04W01001	MW-A	6-Apr-00	5.70	5.2	410	7.28	7.20	Peristaltic	0.15	1.5	0.30	19.18	19.21	23.30	117
04W01001	MW-A	10-Aug-00	0.20	7.6	449	7.08	13.90	Peristaltic	0.13	1.25	0.25	19.43	19.43	23.30	-117
04W01001	MW-A	10-Nov-00	5.49	46.1	573	7.21	7.79	Peristaltic	0.13	1.25	0.26	18.86	19.21	23.30	-41
04W01001	MW-A	3-May-01	0.41	166	559	6.67	8.19	Peristaltic	0.13	1.25	0.22	18.82	18.97	23.30	-90
04W01001	MW-A	30-Nov-01	6.65	73.9	229	7.19	8.00	Peristaltic	0.13	1.25		19.35	20.47	23.30	117
582431	Temp 1(N)	6-Apr-00	0.11	0.9	906	6.67	8.70	Ded. B. Pump	0.75	20.25	6.5	18.62	18.62	49.80	-89
582431	Temp-1(N)	11-Aug-00	< 0.1	0.96	621	6.73	9.10	Ded. B. Pump	0.75	20.25	6.5	19.16	19.16	49.80	-77
582431	Temp-1(N)	9-Nov-00	0.17	0.9	959	6.64	8.23	Ded. B. Pump	0.75	20.25	6.5	18.71	18.71	49.80	-120
582431	Temp 1(N)	4-May-01	0.17	4.08	1018	6.11	8.66	Ded. B. Pump	0.75	20.25	6.5	18.61	18.62	49.80	-93
582431	Temp-1(N)	20-Sep-01	0.36	4.69	1487	6.61	8.63	Ded. B. Pump	0.75	20.25	6.5	18.63	18.63	49.80	-110
582431	Temp-1	1-Dec-01	0.34	2.3	399	6.56	8.37	Ded. B. Pump	0.75	20.25		18.90	18.90	49.80	-119
582432	Temp 2(S)	6-Apr-00	6.60	3.1	530	6.81	8.30	Ded. B. Pump	0.75	20.25	6.6	18.53	18.53	28.70	199
582432	Temp-2(S)	11-Aug-00	1.20	0.74	522	6.84	8.80	Ded. B. Pump	0.75	20.25	6.3	18.98	18.98	28.70	61
582432	Temp-2(S)	9-Nov-00	0.59	1.4	680	6.79	10.10	Ded. B. Pump	0.75	20.25	6.6	18.58	18.58	28.70	-99
582432	Temp 2(S)	4-May-01	0.91	1.59	708	6.40	7.65	Ded. B. Pump	0.75	20.25	6.7	18.46	18.46	28.70	29
582432	Temp-2	20-Sep-01	4.44	0.26	791	6.75	8.91	Ded. B. Pump	0.75	20.25	6.65	18.46	18.46	28.70	-10
582432	Temp-2	1-Dec-01	0.26	2.4	333	6.74	9.51	Ded. B. Pump	0.75	20.25		18.83	18.83	28.70	-132

FIGURE 2
KUMMER SANITARY LANDFILL - SW-031
Elevation of Groundwater in Shallow Wells

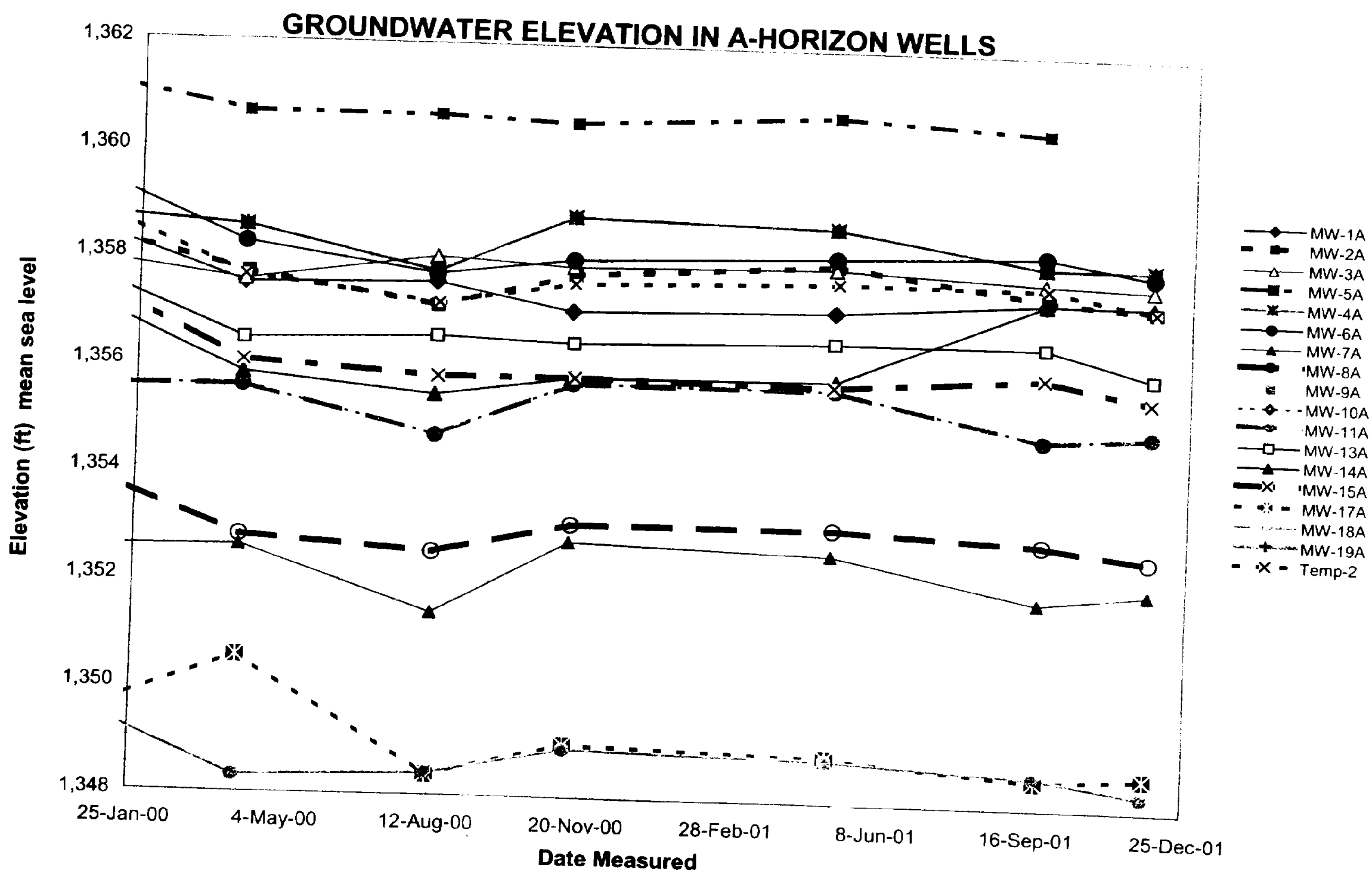


FIGURE 3
KUMMER SANITARY LANDFILL
Elevation of Groundwater in Deep Wells

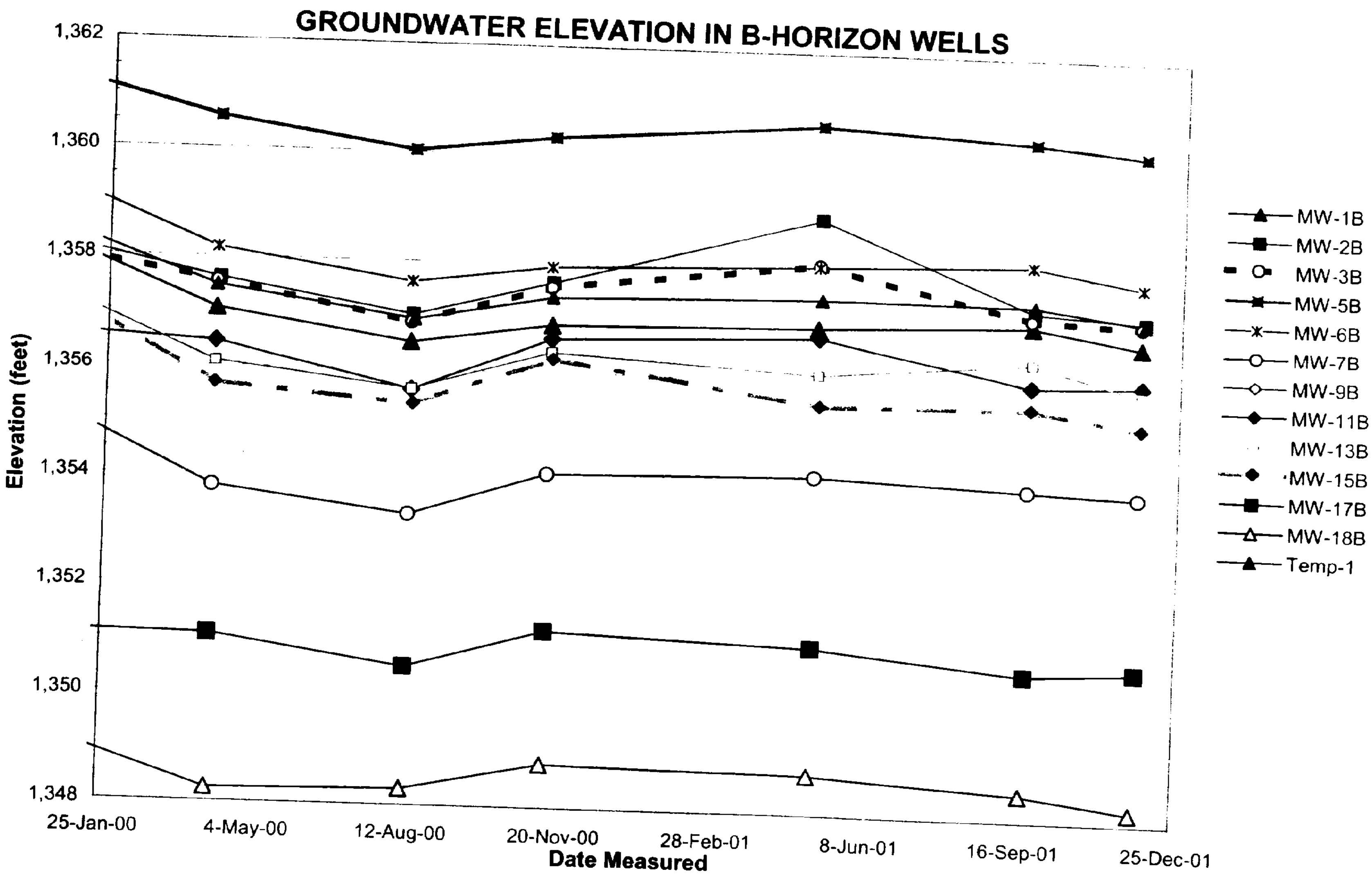


FIGURE 4
KUMMER SANITARY LANDFILL
Elevation of Groundwater in Deepest Wells

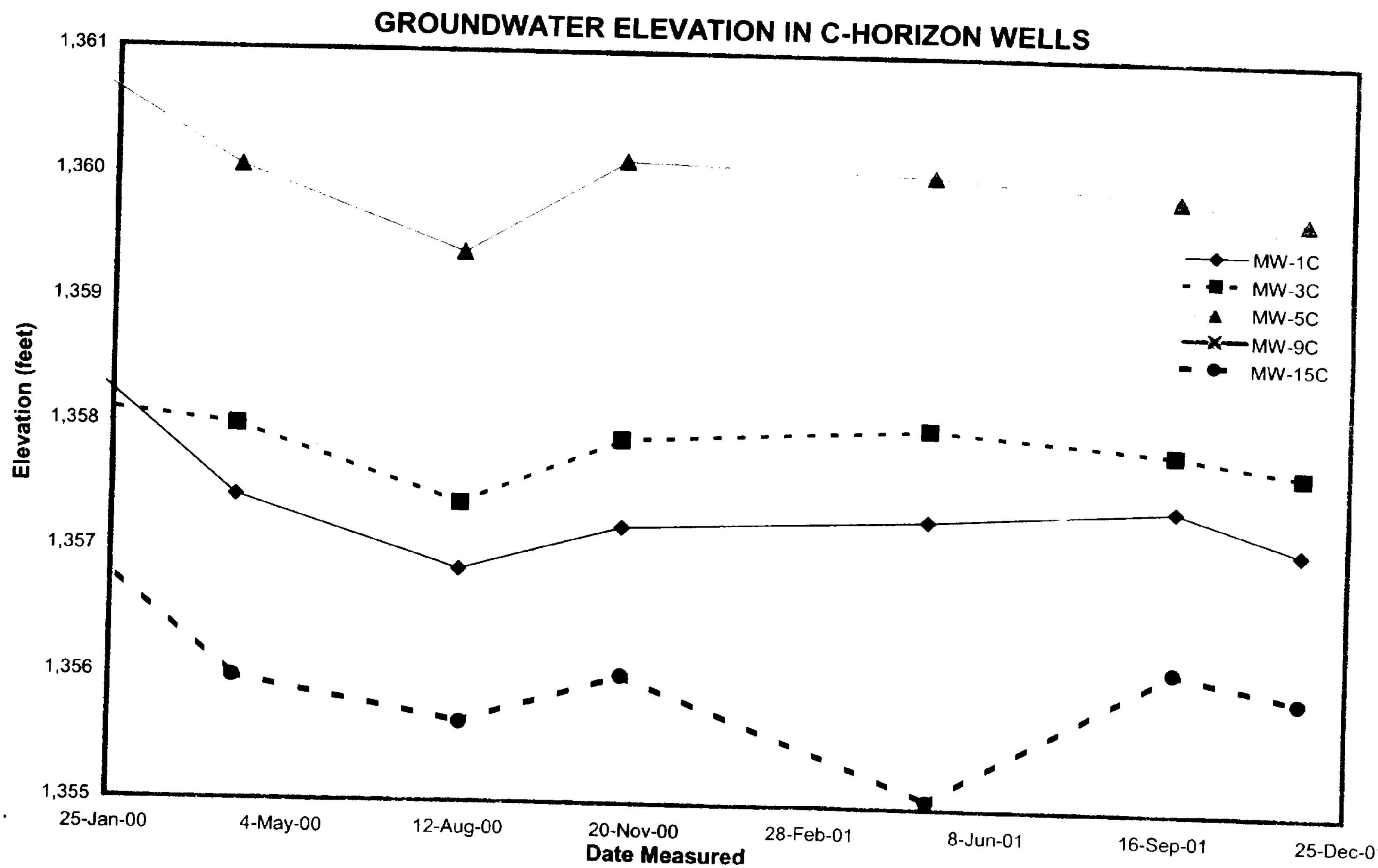
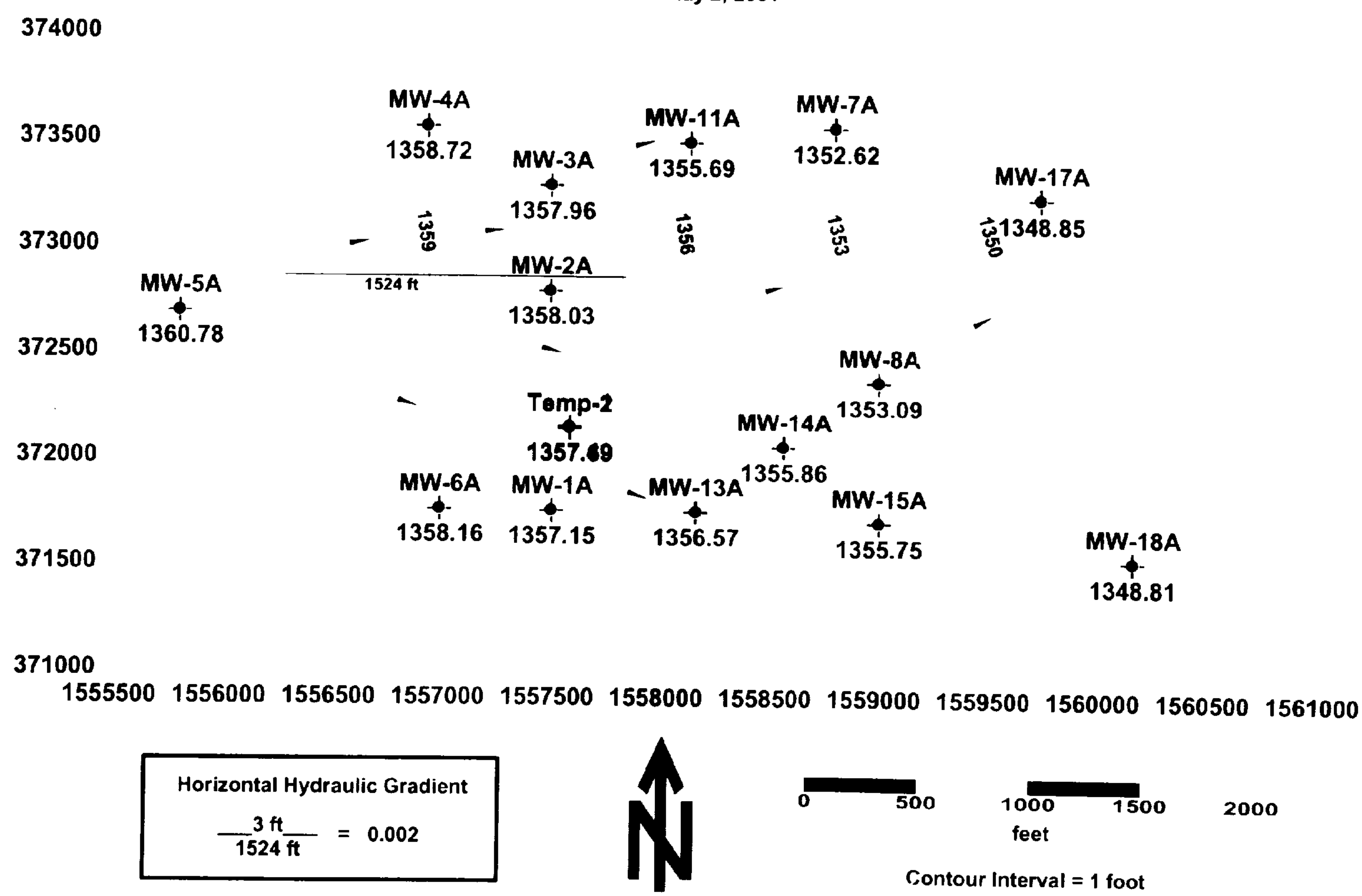


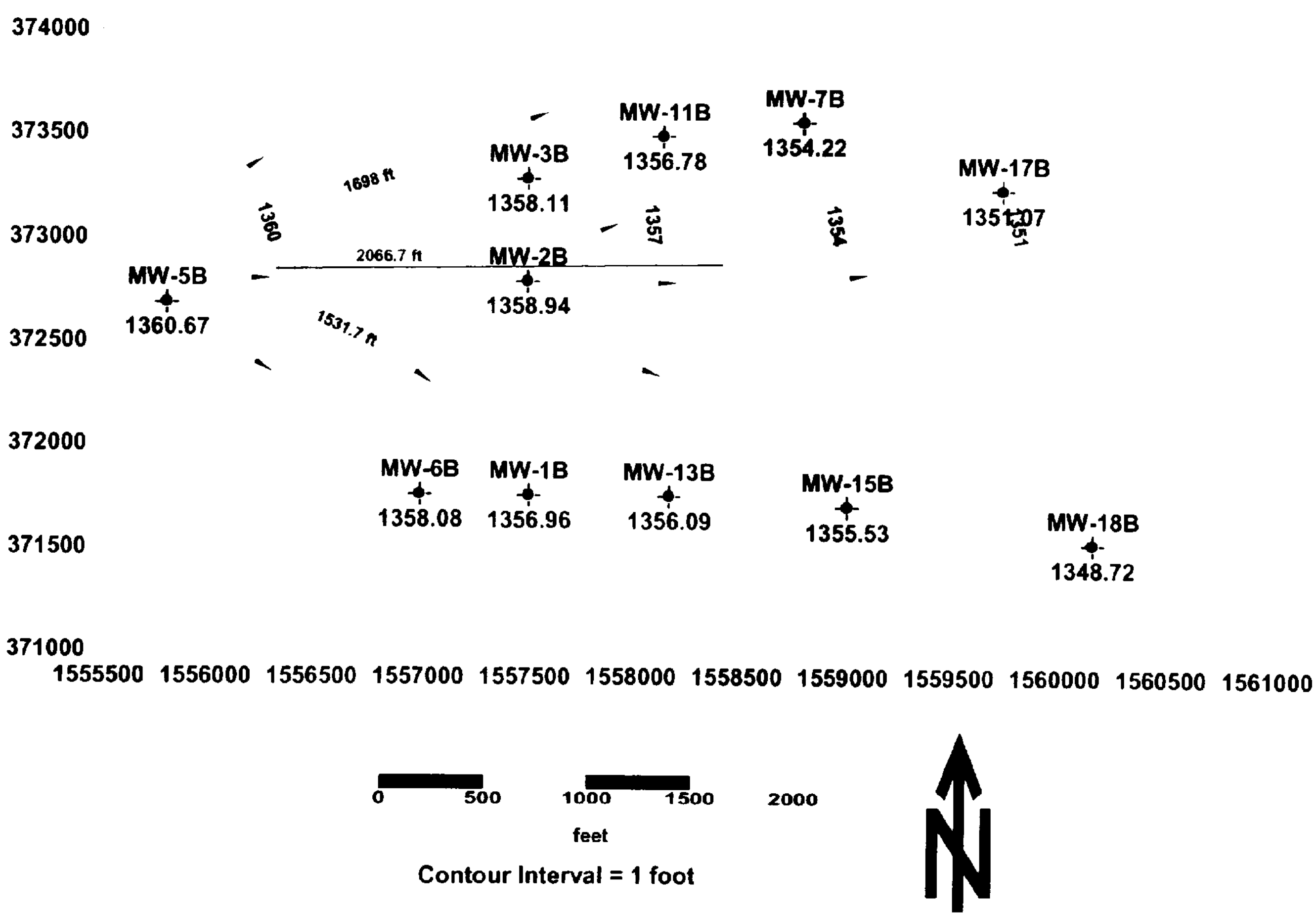
FIGURE 5a
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Shallow Monitoring Wells
May 2, 2001



Horizontal Hydraulic Gradient

$\frac{3\ ft}{1524\ ft} = 0.002$

FIGURE 5b
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Deep Monitoring Wells
May 2, 2001

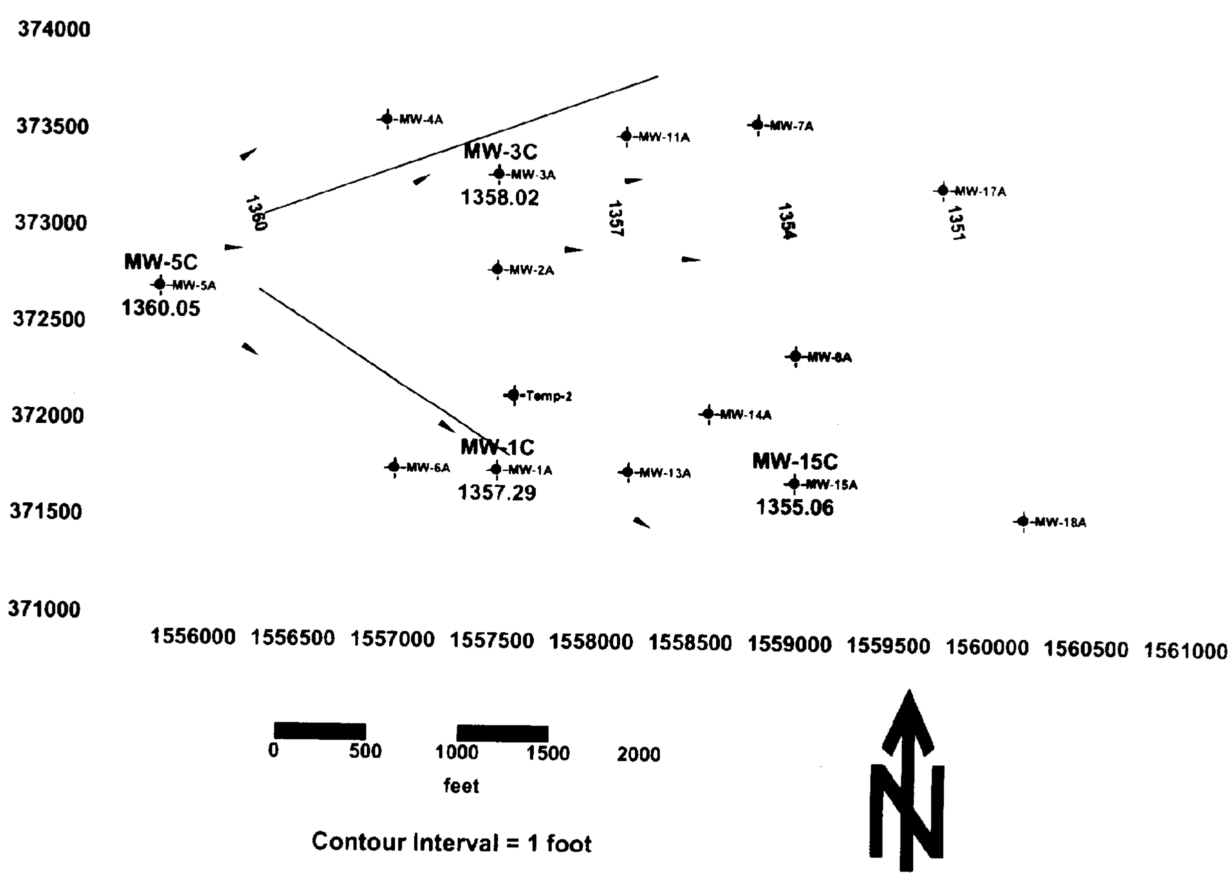


Northern
Horizontal Hydraulic Gradient
$\frac{3\text{ ft}}{1698\text{ ft}} = 0.0018$

Central
Horizontal Hydraulic Gradient
$\frac{4\text{ ft}}{2066.7\text{ ft}} = 0.002$

Southern
Horizontal Hydraulic Gradient
$\frac{3\text{ ft}}{1531.7\text{ ft}} = 0.002$

FIGURE 5c
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Very Deep Monitoring Wells
May 2, 2001



Northern
Horizontal Hydraulic Gradient

$$\frac{4\ \text{ft}}{1977\ \text{ft}} = 0.002$$

Central
Horizontal Hydraulic Gradient

$$\frac{3\ \text{ft}}{1852\ \text{ft}} = 0.0016$$

Southern
Horizontal Hydraulic Gradient

$$\frac{3\ \text{ft}}{1636\ \text{ft}} = 0.0018$$

FIGURE 6a
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Shallow Monitoring Wells
September 19, 2001

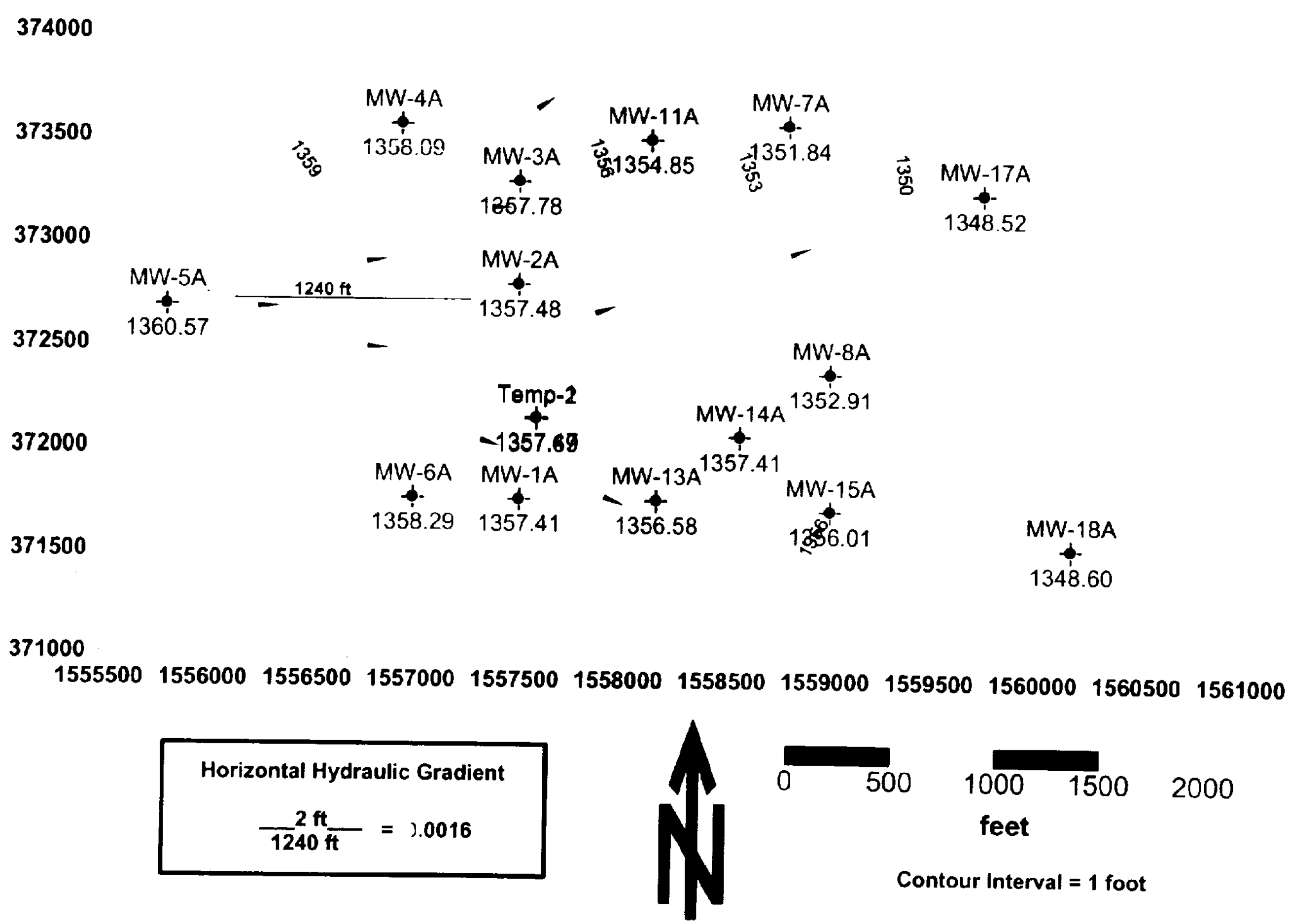


FIGURE 6b
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Deep Monitoring Wells
September 19, 2001

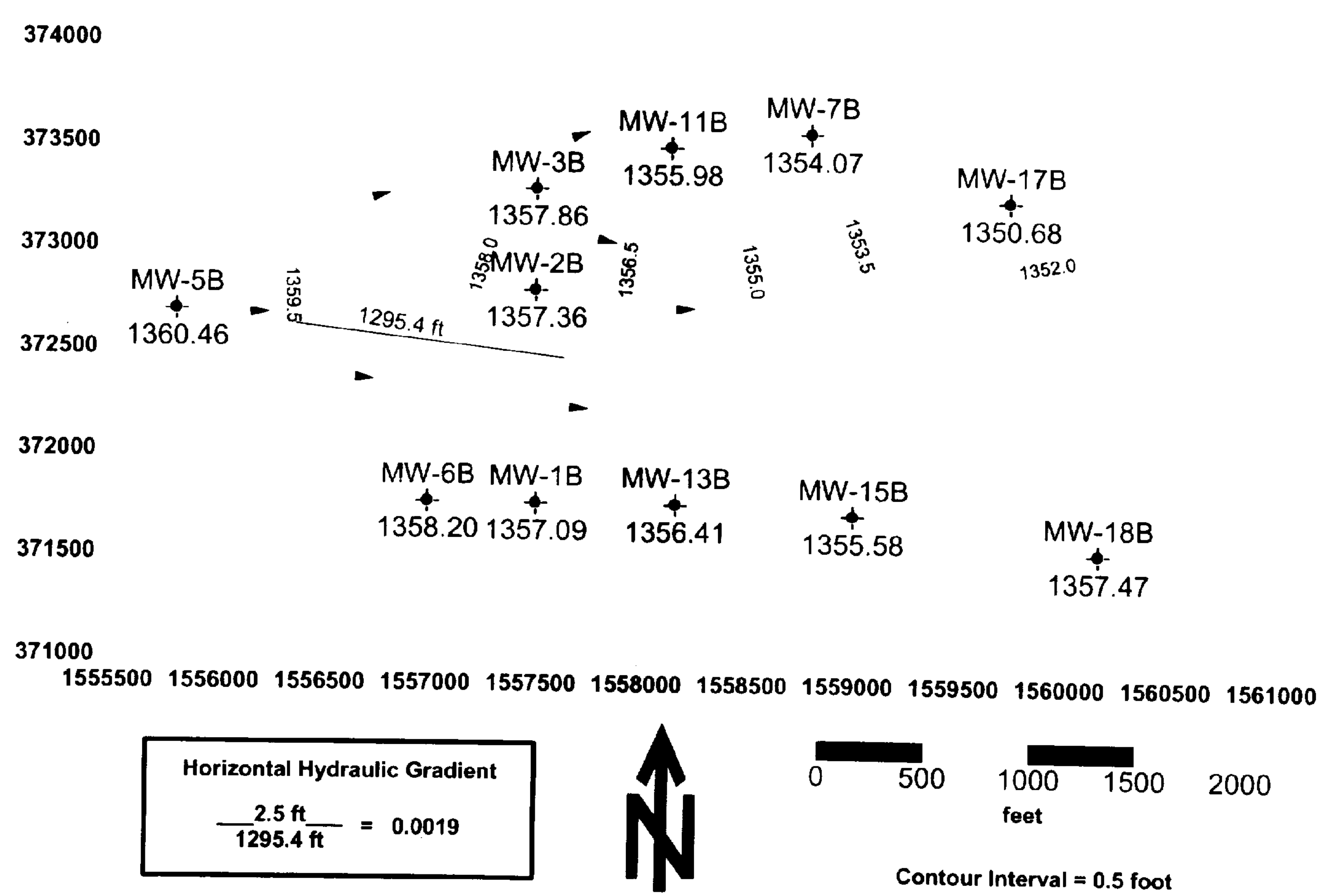
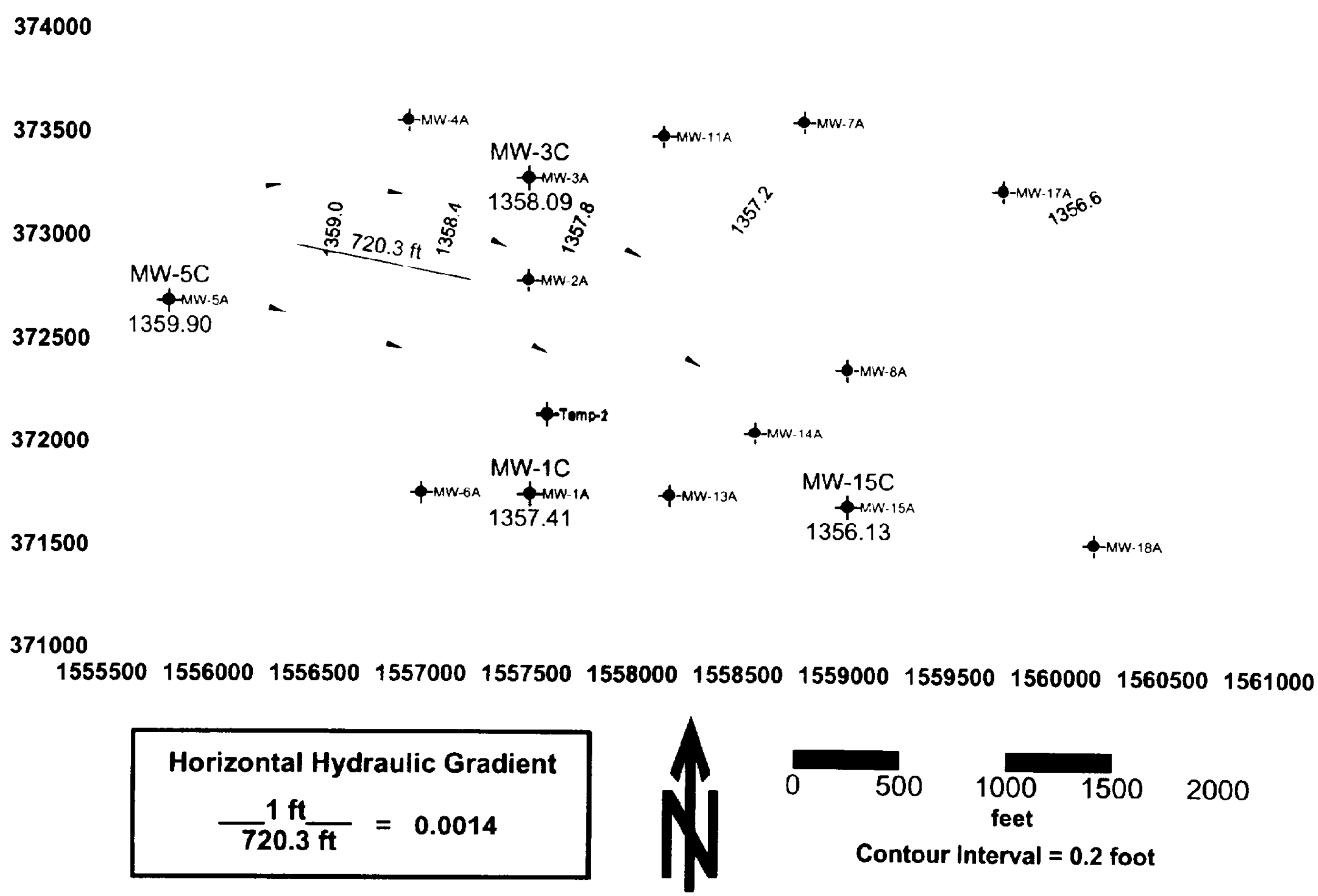


FIGURE 6c
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Deepest Monitoring Wells
September 19, 2001



Horizontal Hydraulic Gradient

$$\frac{1\ \text{ft}}{720.3\ \text{ft}} = 0.0014$$

FIGURE 7a
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Shallow Monitoring Wells
December 29, 2001

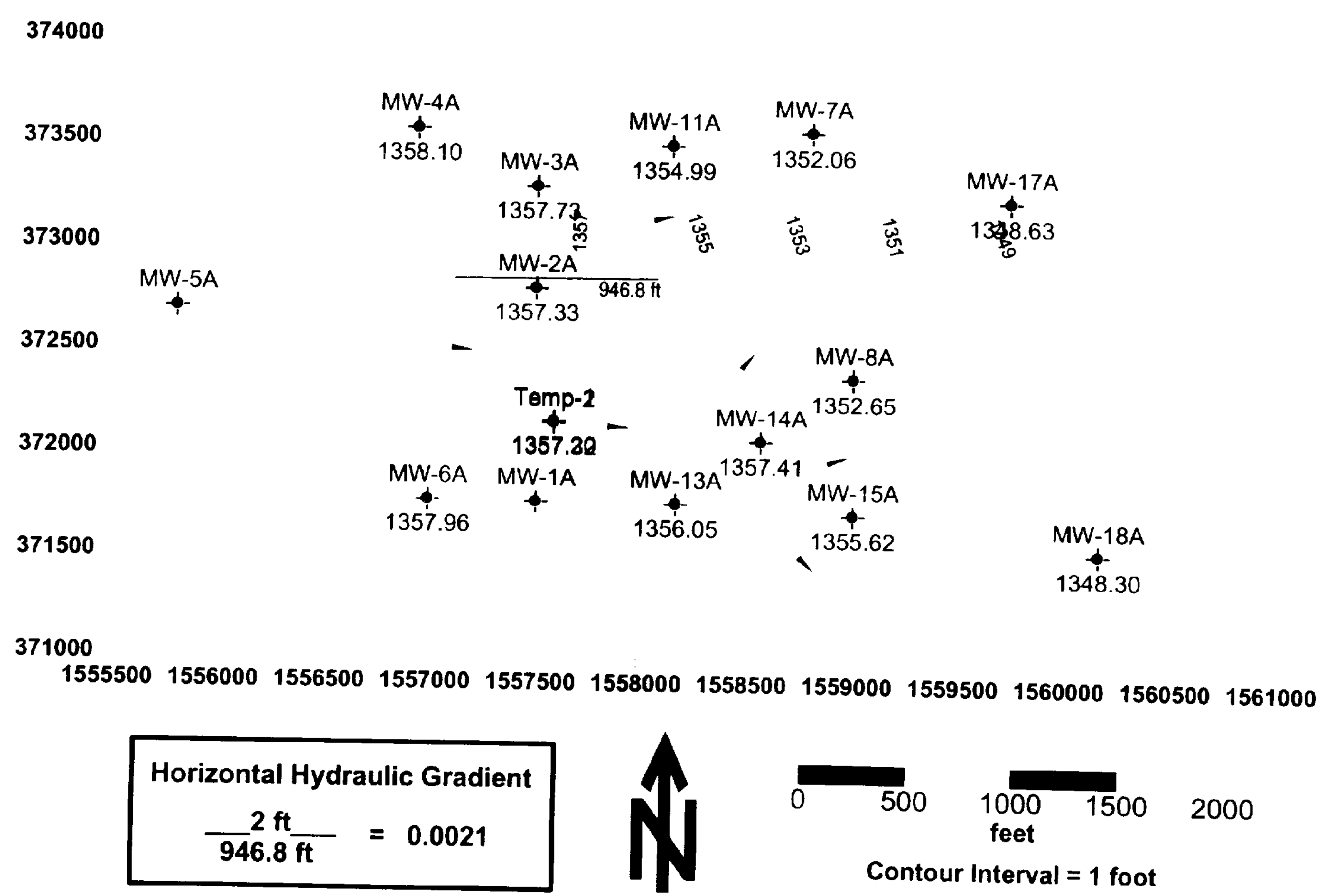


FIGURE7b
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Deep Monitoring Wells
November 29, 2001

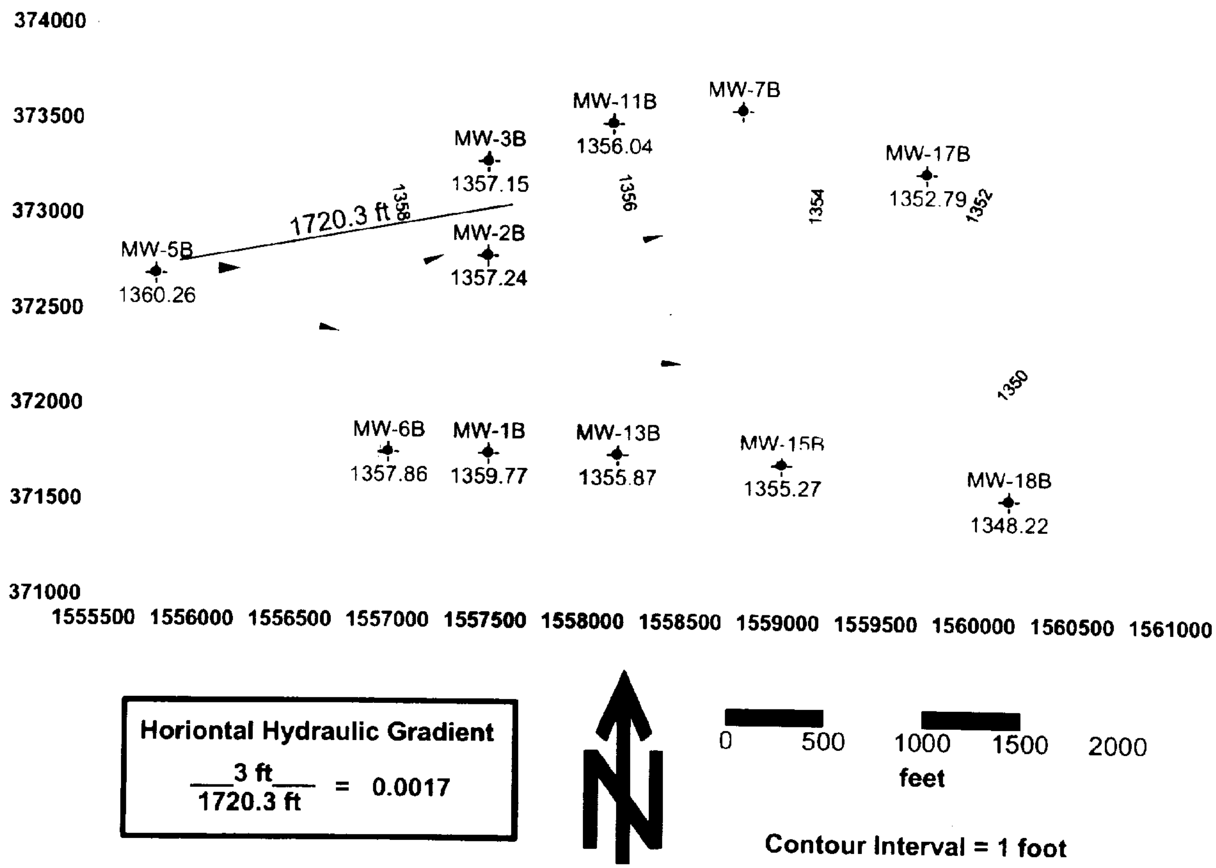
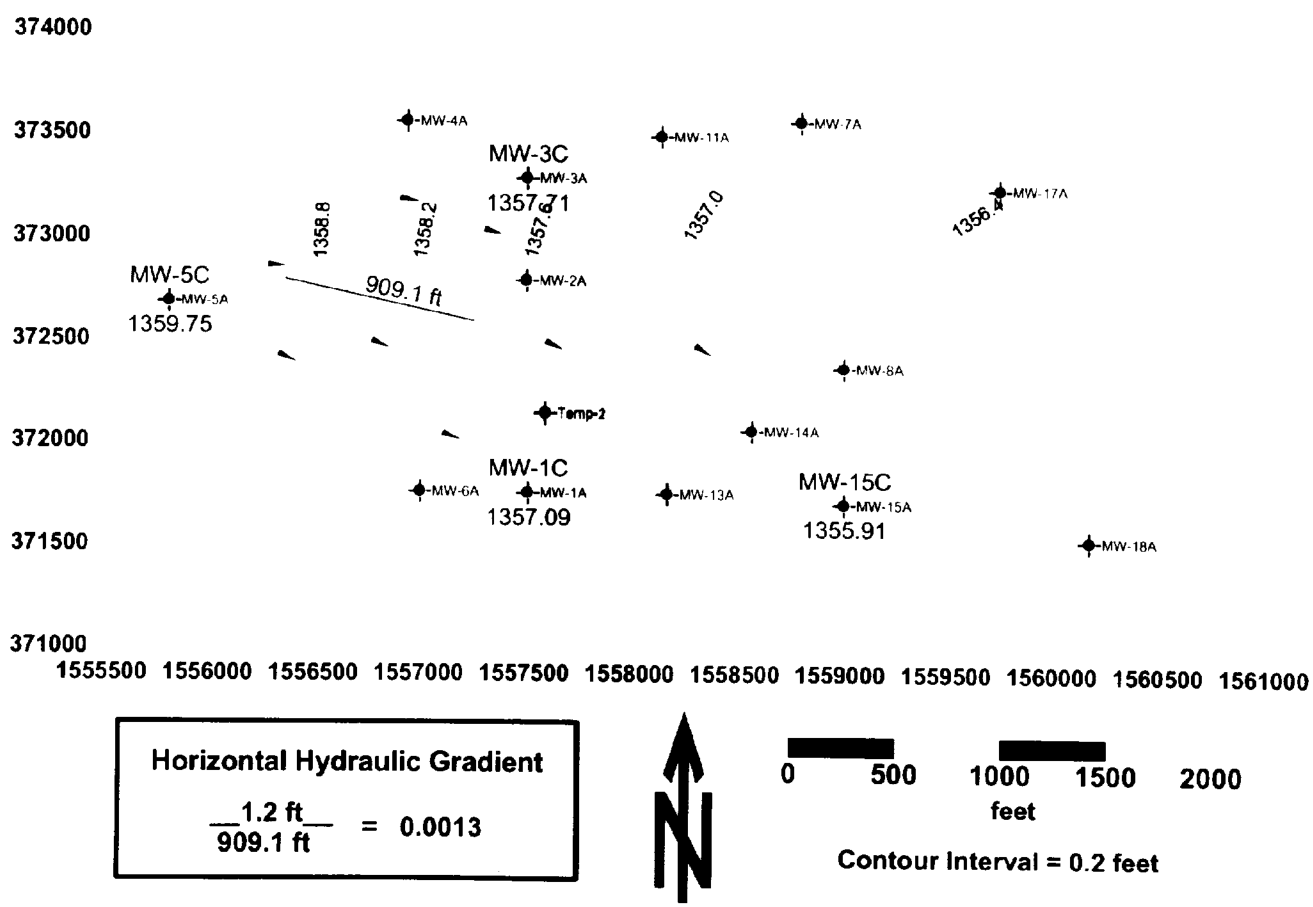


FIGURE 7c
KUMMER SANITARY LANDFILL
Direction of Groundwater Flow in Deepest Monitoring Wells
November 29, 2001



Horizontal Hydraulic Gradient

$$\frac{1.2\text{ ft}}{909.1\text{ ft}} = 0.0013$$

FIGURE 8

KUMMER SANITARY LANDFILL

Total VOCs in A-Horizon Wells Exceeding Standards

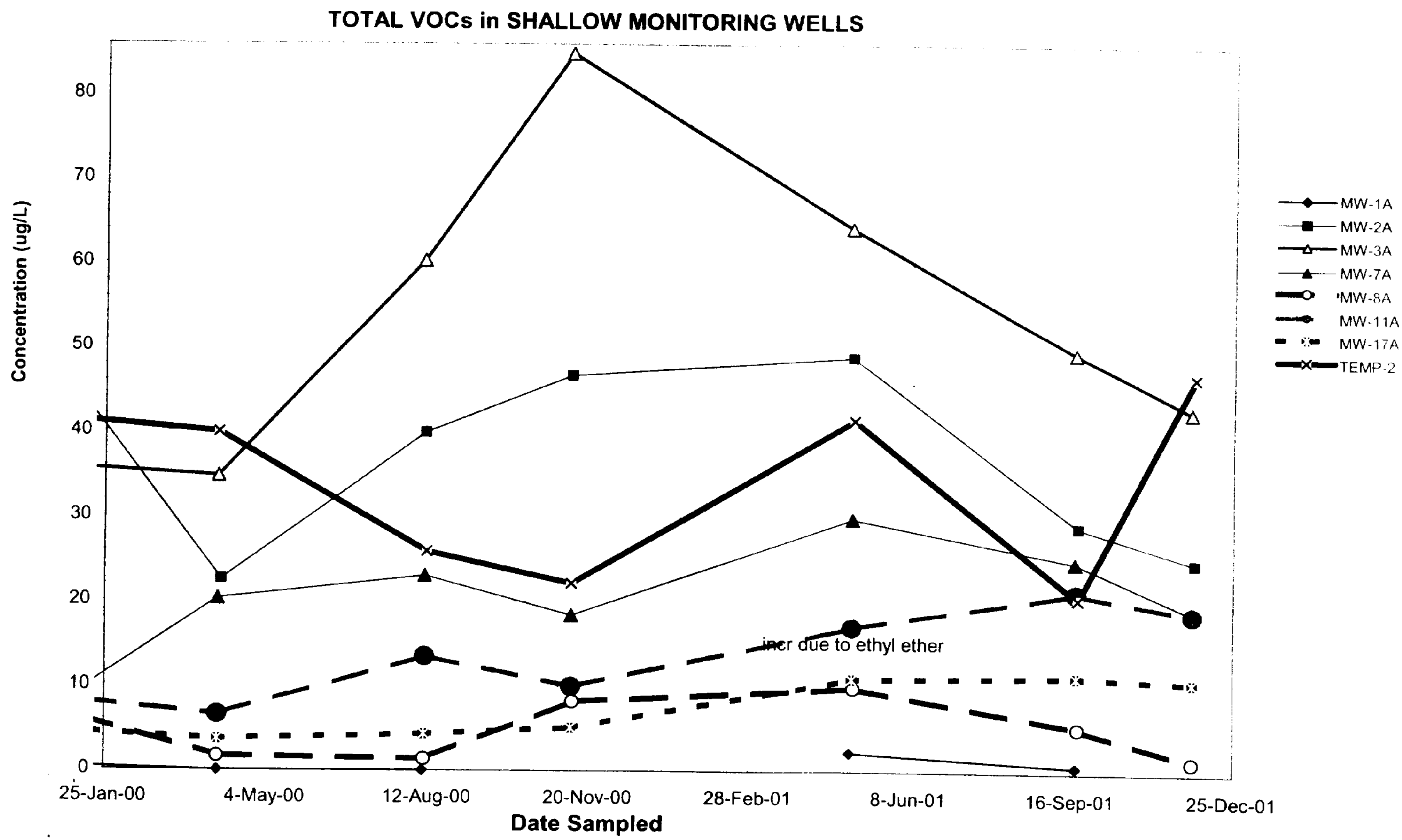


FIGURE 9
KUMMER SANITARY LANDFILL
Total VOCs in B-Horizon Wells Exceeding Standards

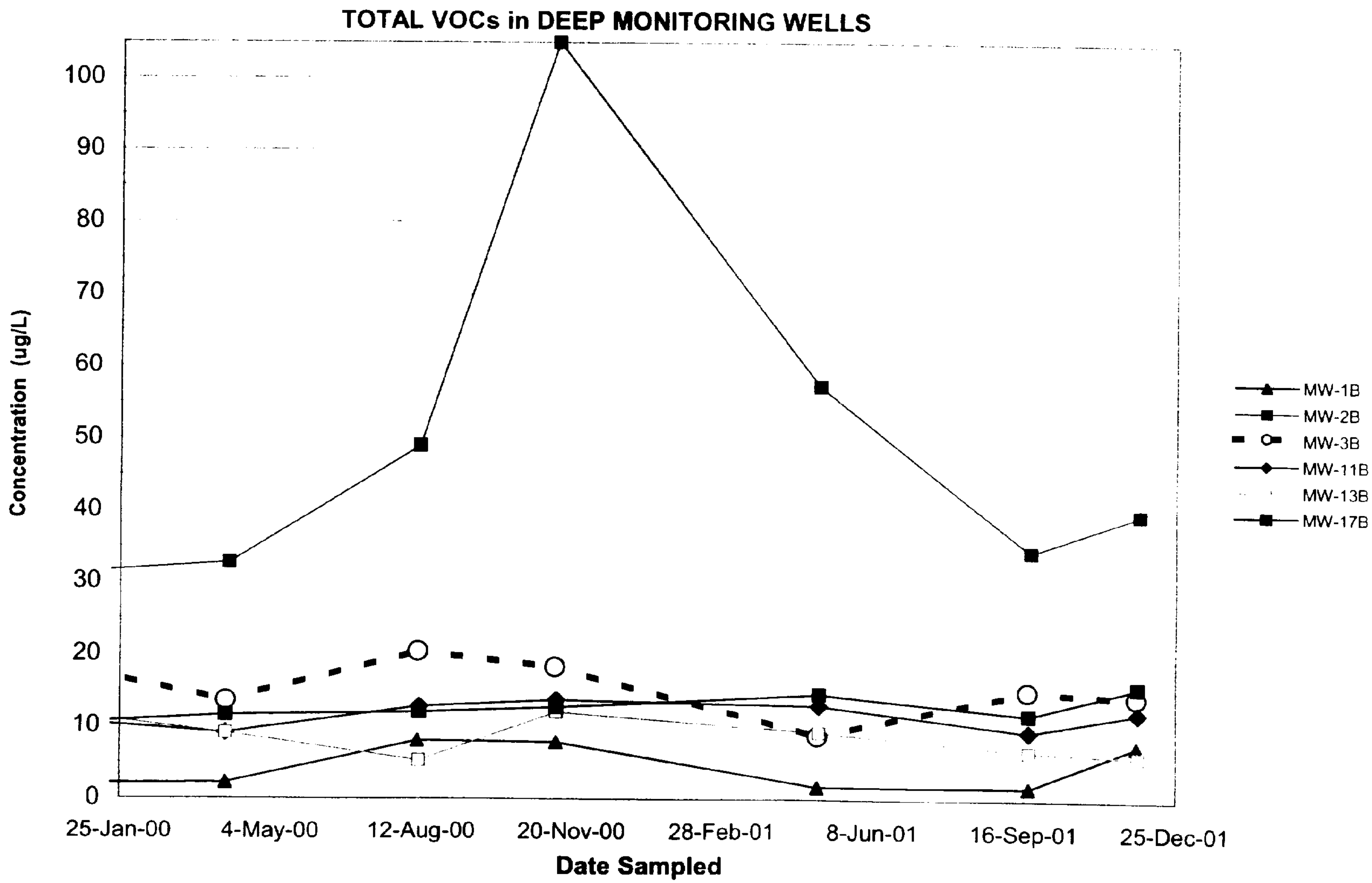


FIGURE 10
KUMMER SANITARY LANDFILL
Levels of Vinyl Chloride in Monitoring Wells since 1995

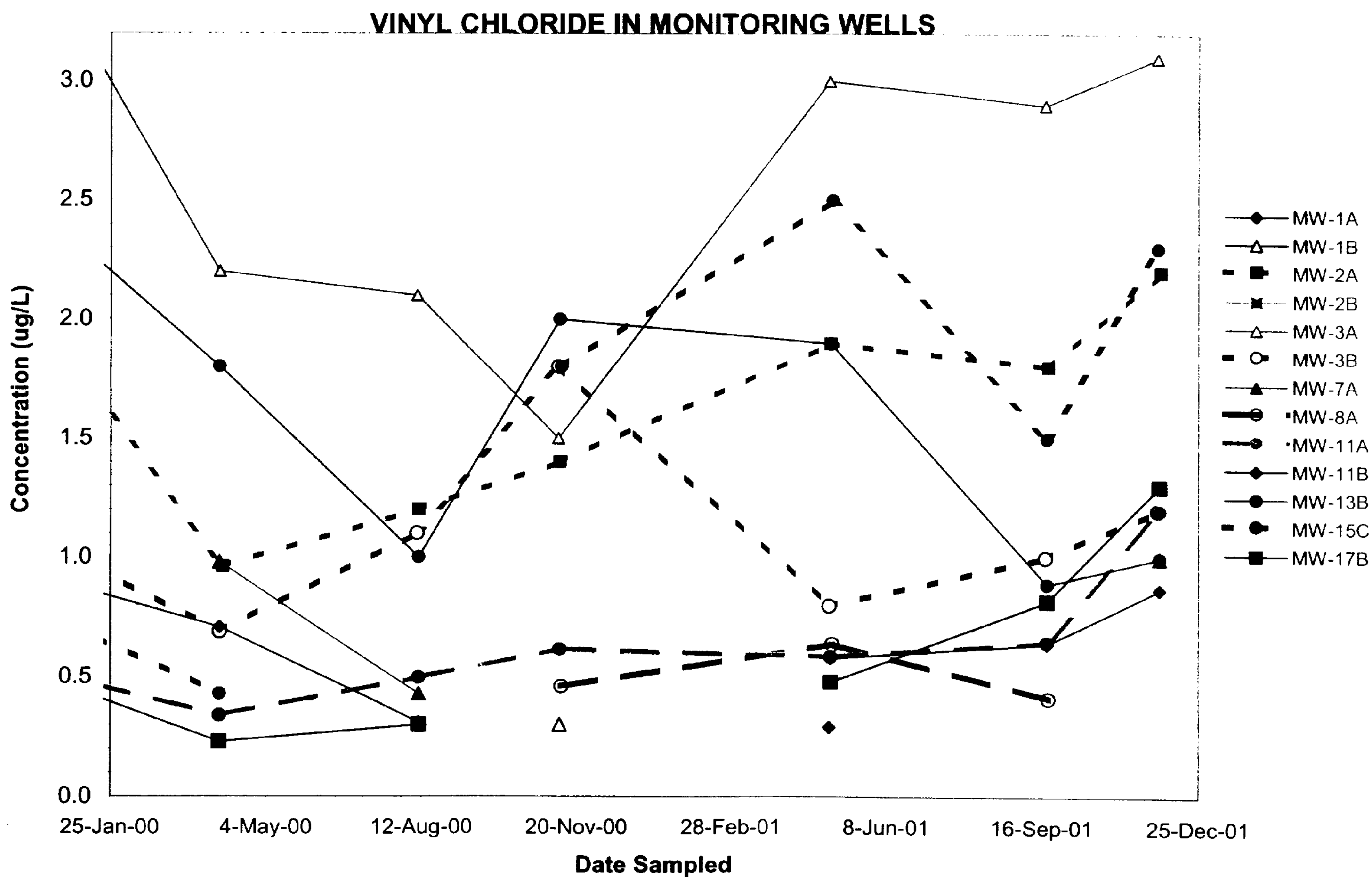
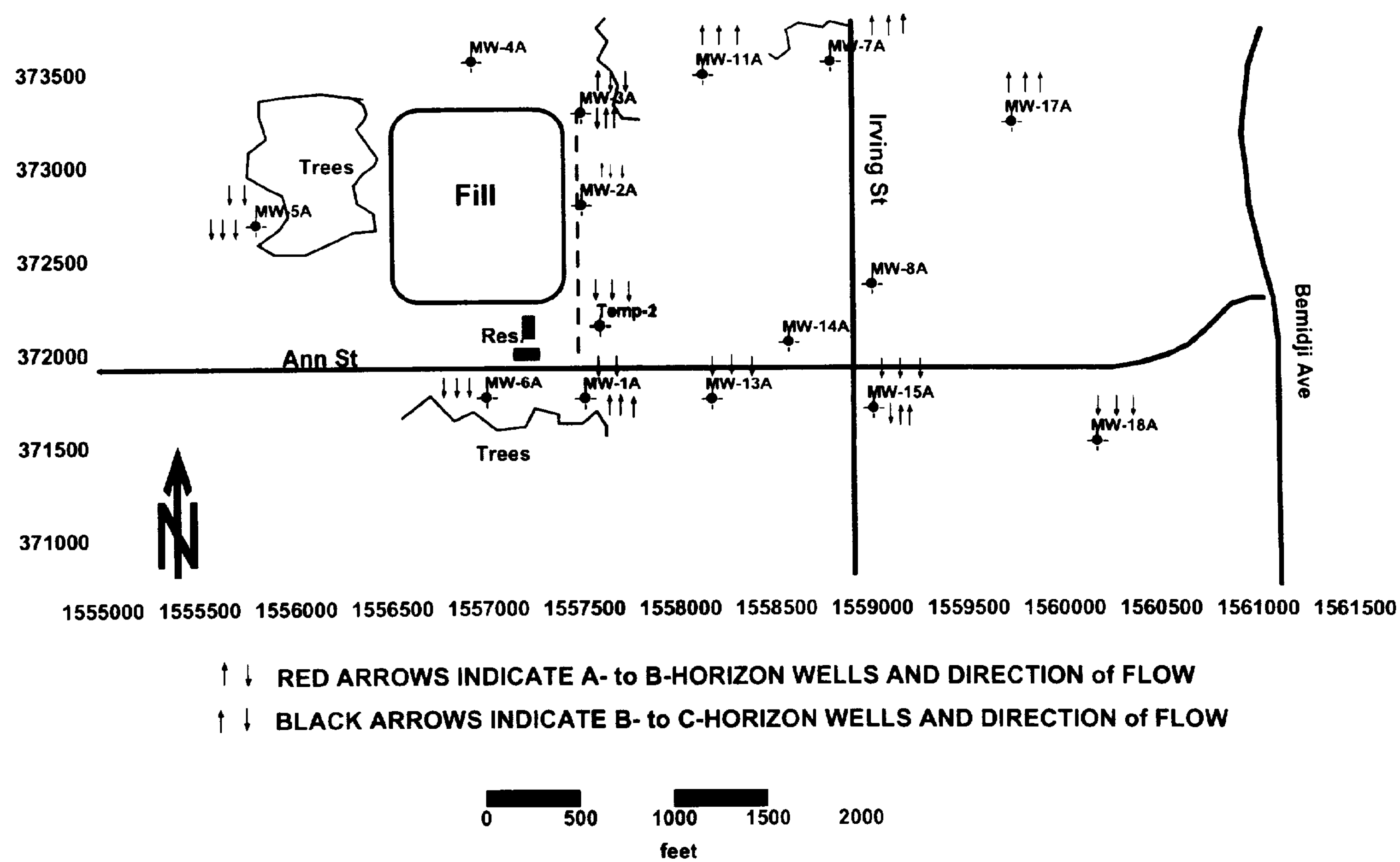
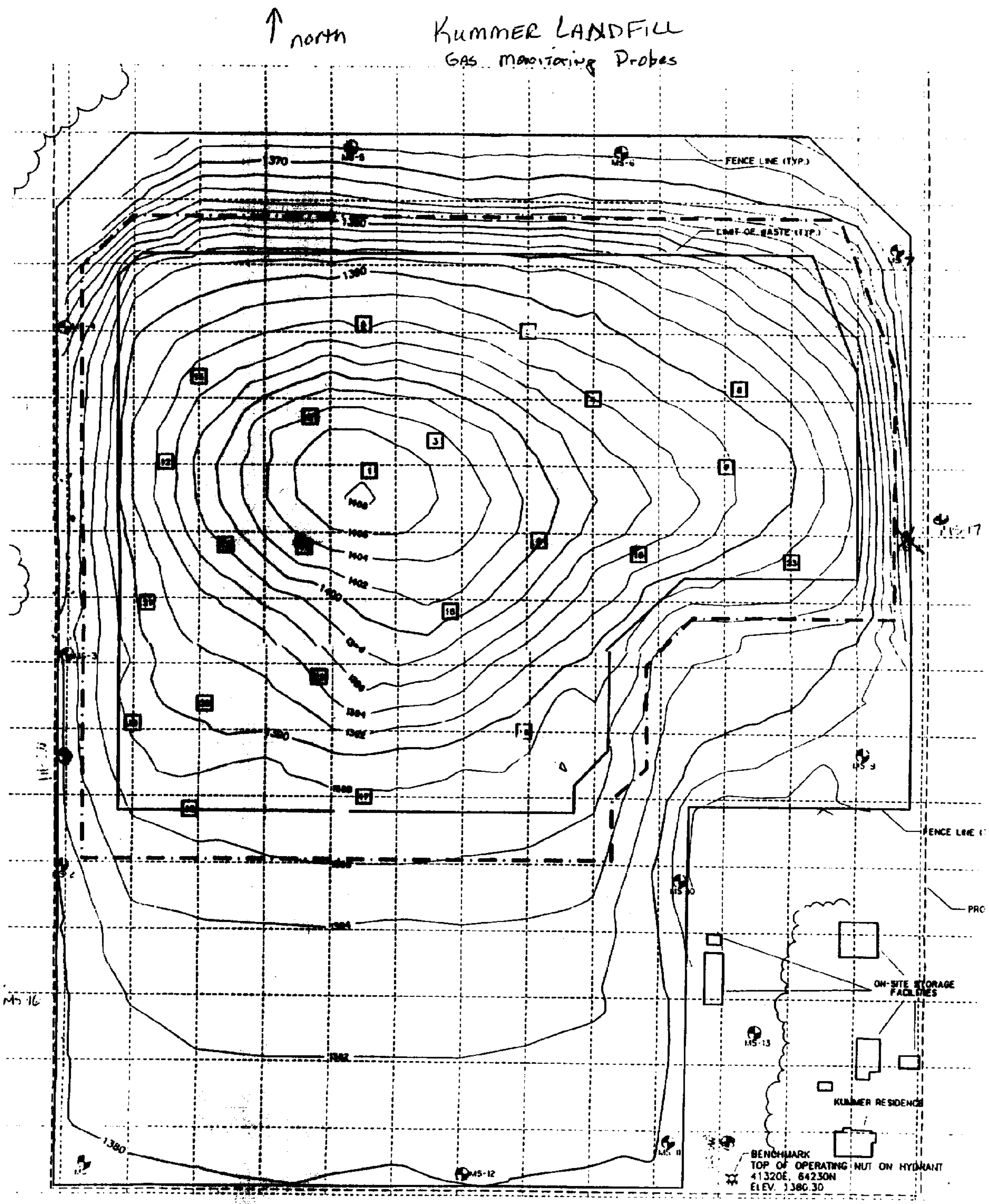


FIGURE 11
KUMMER SANITARY LANDFILL
Graphical Depiction of Vertical Gradients Between Flow Regimes




north
KUMMER LANDFILL
Gas Monitoring Probes
FENCE LINE (TYP.)
LIMIT OF WASTE (TYP.)
ON-SITE STORAGE FACILITIES
KUMMER RESIDENCE
BENCHMARK
TOP OF OPERATING NUT ON HYDRANT
41320E, 64230N
ELEV. 1380.30
MS-12
MS-13
MS-16